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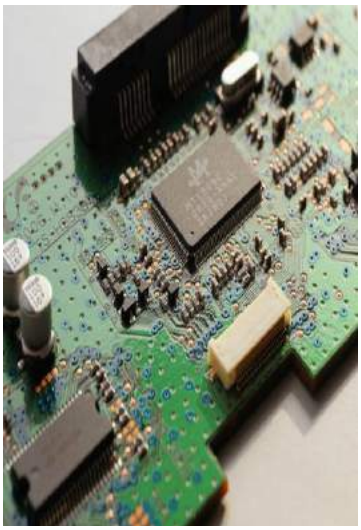


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Improved Parallel PSO Inversion for the MT Sounding Data

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***Abstract*—The magnetotelluric (MT) method has become more widely used in hydrocarbon exploration. The inversion of MT data, which can determine the electrical structure of subsurface, is a nonlinear and multimodal optimization problem. Particle swarm optimization (PSO) algorithm is a good solver for this geophysical inversion problem, whereas it has a shortage of heavy computation time. An improved parallel adaptive PSO inversion algorithm for MT data is proposed in order to decrease the computation time. The performance of the proposed algorithm was evaluated on the Dawn 4000L supercomputer using the synthetic MT data of 1D layered geo-electrical models of three and four layers. The numeric results show that the proposed algorithm can obtain the as good solution as the serious PSO inversion algorithm, and can reduce the computation time obviously when more computing nodes been employed. This result indicates that proposed improved parallel inversion algorithm can deal with the computation time problem and provide theory and technology support the MT data non-linear inversion based on PSO.**

Keywords- improved parallel PSO; non-linear inversion; Magnetotelluric (MT); coarse granularity

I. INTRODUCTION

The magnetotelluric (MT) method utilizes naturally occurring low-frequency electro-magnetic waves to determine the electrical resistivity of the Earth's subsurface. A knowledge of the resistivity is important since rock types important to hydrocarbon exploration can be differentiated on the basis of resistivity value [1, 2]. It has some advantages such as low cost, large probing depth, not affected by high-resistivity shielding and high resolution to the low-resistivity layer. In the last decades, the MT method has become more widely used in hydrocarbon exploration [3].

Data inversion is one of the core issues of the MT method, which is classified into linear and nonlinear categories. To overcome the flaws of the classical linear inversion method, some nonlinear inversion methods, such as Monte Carlo, simulated annealing and genetic algorithm are employed to the MT inversion [4]. However, they have some disadvantages [2].

The particle swarm optimization (PSO) is a relative novel global optimization algorithm based on swarm intelligence [5]. It has several advantages including fast convergence, strong capability of global optimization and simple parameter adjustment, and has been successfully applied to many fields [6]. In recent years it has also been introduced into the geophysical inversion [7-11]. Although the disadvantage, such as local optimum, of geophysical inversion based on PSO has been improved by employing the adaptive inertial weight, it still has the problem of heavy computation time when the forward modeling becomes more complex [2]. Parallel implementation can reduce the computation time of inversion obviously.

Message Passing Interface (MPI) is one of the most popular parallel computing software environment [12]. An asynchronous parallel adaptive PSO inversion algorithm based on MPI for the MT oil-gas exploration data is proposed in this paper. It is applied to the inversion of the synthetic MT data and its parallel performance is analyzed.

II. METHODOLOGY

A. Forward modeling

Assume an 1D layered model through a cross section of n layers, of which from up to down the resistivities are $\rho_1, \rho_2, ..., \rho_n$, respectively, and the depths are $h_1, h_2, ..., h_n$, respectively, where $h_n = \infty$. For such a 1D layered model, apparent resistivity ρ_a and phase ϕ_a can be calculated as follows:

$$\rho_a(\omega) = \frac{|Z(\omega)|^2}{\omega\mu}, \quad \phi_a = \arctan\frac{\mathrm{Im}(Z)}{\mathrm{Re}(Z)} \tag{1}$$

Where $\omega = 2\pi T$ is angular frequency, μ is magnetic permeability, $Z(\omega)$ is wave impedance on the surface that can be calculated by the following recurrence formula:

$$Z_i = Z_{0i}\frac{Z_{0i}(1-e^{-2k_ih_i}) + Z_{i+1}(1+e^{-2k_ih_i})}{Z_{0i}(1+e^{-2k_ih_i}) + Z_{i+1}(1-e^{-2k_ih_i})}, Z_N = \frac{\omega\mu}{k_N} = Z_{0N} \tag{2}$$

Where $k_i = \sqrt{i\omega\mu/\rho_i}$ is the complex wave numbers of the *i*-th layer, Z_{0i} is the characteristic impedance of the *i*-th layer, and Z_i is the wave impedance of the top of the i-th layer.

The presentation above indicates that apparent resistivity and phase on N-layer geo-electrical section can be expressed by functions of signal periods and section parameters:

$$\rho_a = f_1(\rho_1, \rho_2, ..., \rho_N, h_1, h_2, ..., h_{N-1}, T) \quad (3)$$

$$\phi_a = f_2(\rho_1, \rho_2, ..., \rho_N, h_1, h_2, ..., h_{N-1}, T) \quad (4)$$

B. Improved PSO

In the PSO algorithm [5], the optimal solution is obtained through collaboration among individual which represented by particles. Suppose that the search space is of n dimensions, total number of particles is m, the position of the *i*-th particle in the *n*-dimensional space is xi, and its flight speed is vi. Each particle has an adaptive value determined by an optimization target function, and is aware of the best position pi that is found till now by itself and its current position, as well as the optimal position pg of the whole swarm found till present. Then the speed and the position of each particle can be updated by the following formulas:

$$v_i^{k+1} = wv_i^k + c_1 r_1 (p_i - x_i^k) + c_2 r_2 (p_g - x_i^k) \quad (5)$$

$$x_i^{k+1} = x_i^k + v_i^{k+1} \quad (6)$$

where v_i^k is the flight velocity of the *i*-th particle after *k*-th iteration, x_i^k is the position of the *i*-th particle after *k*-th iteration, r_1 and r_2 are random parameters evenly distributed in 0~1, c_1 and c_2 are weight factors, and w is inertial weight which is important to the balance between global exploration and local exploitation.

The Adaptive PSO [2] adjust the inertial weight dynamically according to the particle velocity of the population as follows:

$$\begin{cases} \text{if } v_{avg}^k > v_e^k, \text{ then } w(k+1) = w(k)/p; \\ \text{if } v_{avg}^k < v_e^k, \text{ then } w(k+1) = w(k) * p; \\ \text{if } v_{avg}^k = v_e^k, \text{ then } w(k+1) = w(k), \end{cases} \quad (7)$$

where

$$v_{avg}^k = (\sum_{i=1}^{m}\sum_{j=1}^{n} | v_{ij}^k |) / (m*n)$$

is the average velocity of the *k*-th generation population,

$$v_e^k = v_0 e^{-(2k/(T_{\max}-T_1))^2}$$

is the expected velocity of the *k*-th generation population which attenuates exponentially, here $T_{\max}$ is the maximum evolution iteration, T_1 is the local exploitation iteration, $T_{\max} - T_1$ the iteration of global exploration, and parameter *p* is the change rate of inertial weight.

C. Parallel Strategy

Some results [12] reported show that the coarse granularity is more effective then the fine granularity, because it can reduce the communication time so as to gain better performance. So we choose the coarse granularity in our parallel implementation of inversion, that is to say we assign a number of particles to one processor.

We regard the particles in the same processor as an independent sub-swarm, which has the full information. The particles in the same processor (sub-swarm) can construct the optimal solution independently guided by their own information. Different sub-swarm (different nodes) interact each other by exchanging the information such as sub-swarm optimal solution. We name the dividing strategy as coarse granularity interacting multi particle swarms.

In order to reduce the communication time of parallel computing, we choose the asynchronous parallel strategy, which means each node (sub-swarm) run certain iterations locally and exchange the information each other controlled by the master node and then begin the next certain iterations.

D. Improved Parallel PSO inversion algorithm

The forward model can be written as $d = A(m)$, where m is a model parameter, A is forward functional, and d is the theoretical value corresponding to the model m. Inversion is to solve the model parameter m from the observed value d^{obs}, which makes the fitness error between the theoretical value $d = A(m)$ and the observed value d^{obs} least. The objective function of inversion is defined as the norm L_2 of the difference between the observed and theoretical values to describe the fitness degree, which is expressed as

$$P(m) = \| d^{obs} - A(m) \|^2 \to \min \quad (8)$$

For an N-layer geo-electrical section, the model parameter m is a (2N-1) dimensional vector $(\rho_1, \rho_2, ..., \rho_N, h_1, h_2, ..., h_{N-1})^T$. If the observation is conducted at *K* frequencies, the observed value d^{obs} will is a 2* K dimensional vector $(\rho_1, \rho_2, ...\rho_K, \phi_1, \phi_2, ...\phi_k)^T$, where ρ_i, ϕ_i are apparent resistivity and impedance phase at the i-th frequency. The inversion of MT data for 1D N-layer model is to find the model parameter $m = (\rho_1, \rho_2, ..., \rho_N, h_1, h_2, ..., h_{N-1})^T$, which results a best match between the calculated value $d = A(m)$ from Eqs. (3) and (4) and the observed value d^{obs}.

The improved parallel PSO inversion algorithm is described as follow:

Step 1: Input node number (sub-swarm number) N, particle number S of each sub-swarm;

Step 2: Master node generate N*S parameters of initial model randomly, corresponding to initial positions of N*S particles, and send *i*-th sub-swarm to *i*-th node;

Step 3: Each node calculates each particle's theoretical value $A(m)$ of their own sub-swarm respectively, using formulas (3) and (4);

Step 4: Each node calculates objective function value of each particle of their own sub-swarm by formula (8);

Step 5: Each node selects the best particle of their own sub-swarm;

Step 6: Each node calculate current average velocity v_{avg} of sub-swarm, and adjust inertial weight w of sub-swarm dynamically according to v_{avg} and v_e by formula (7);

Step 7: Each node adjusts the position and velocity of each particle of their own sub-swarm, according to following formulas (5) and (6);

Step 8: If every nodes runs certain iterations, they exchange the information such as the position and velocity of the best particle of each sub-swarm, controlled by the master node;

Step 9: if global convergence or maximum number of iteration is met, go to Step 10, otherwise return to Step 3 to perform next iteration;

Step 10: Master node output result of inversion, finish calculation.

III. Numerical result and analysis

The parallel PSO inversion algorithm is conducted to the noise-free MT data, with 20 particles, maximum iteration number 2000 and learning factor c1=c2=2. In inversion, the value ranges taken are ρ_1 = 0~500Ωm, ρ_2 = 0~100Ωm, ρ_3 = 0~4000Ωm, h_1=0~2000m, h_2=0~4000m, respectively. The inversion result is shown in Table 1, where the sum of relative errors is that of inversion model parameters $(\rho_1, \rho_2, \rho_3, h_1, h_2)$ and real model parameters.

MT data inversion by parallel PSO is made on the four-layer (type HH) model. The result is listed in Table 2. In inversion, 20 particles, maximum iteration number 2000 and learning factor c1=c2=2 are adopted, and the value ranges taken are ρ_1 =0~1000Ωm, ρ_2=0~1000Ωm, ρ_3 = 0~1000Ωm, ρ_4 = 0~1000Ωm, h_1=0~4000m, h_2=0~4000m, h_3=0~4000m, respectively. In these ranges, 20 initial particles are generated randomly for iterative inversion.

Tables 1 and 2 show the accuracy of result of parallel inversion is as well as that of serial one's but it spends much less computation time.

We plot the speedup and speedup efficiency of parallel PSO inversion algorithm in figure 2 following the data of Table 2. From Fig. 2, we can find that more computation nodes lead to less computation time but less speedup efficiency, for inversion.

TABLE I. Parallel inversion results on the three-layer model

Model Parameter	Real Model	MT Inversion			
		1 node	10 nodes	20 nodes	30 nodes
ρ1	110	110.1	110.0	109.9	109.7
ρ2	20	20.01	20.0	20.43	20.1
ρ3	1200	1199.8	1200.0	1200.2	1199.8
h1	500	498.6	498.9	498.2	500.2
h2	2000	2001.3	2001.6	2015.7	2017.3
Running number	--	50	50	50	50
Calculation time(s)	--	482.9	129.4	90.9	75.3

TABLE II. Parallel inversion results on the four-layer model

Model Parameter	Real Model	MT Inversion			
		1 node	10 nodes	20 nodes	30 nodes
ρ1	100	99.9	100.2	99.9	99.9
ρ2	20	19.2	20.6	20.0	19.9
ρ3	300	281.6	300.4	286.5	319.4
P4	10	10.0	10.4	9.9	10.1
h1	600	612.1	595.9	599.5	601.4
h2	1500	1468.4	1502.6	1537.2	1512.1
h3	3000	3176.9	2899.2	3018.3	2979.4
Running number	--	50	50	50	50
Calculation time(s)	--	617	132.2	93.8	79.8

IV. Conclusion

The MT method has become more widely used in hydrocarbon exploration. In order to avoid the disadvantage of heavy computation cost, a synchronous parallel adaptive PSO inversion algorithm is proposed based on MPI. The performance of the proposed algorithm was evaluated on the Dawn 4000L supercomputer using the synthetic MT data of 1D layered geo-electrical models of three and four layers.

The numeric experiments shows that the proposed parallel inversion algorithm can obtain the as good inversion solution as serious version, and can reduce the computation time obviously when more computing nodes been used. This result indicates that proposed asynchronous parallel inversion algorithm can deal with the computation time problem and

provide theory and technology support the MT data non-linear inversion based on PSO.

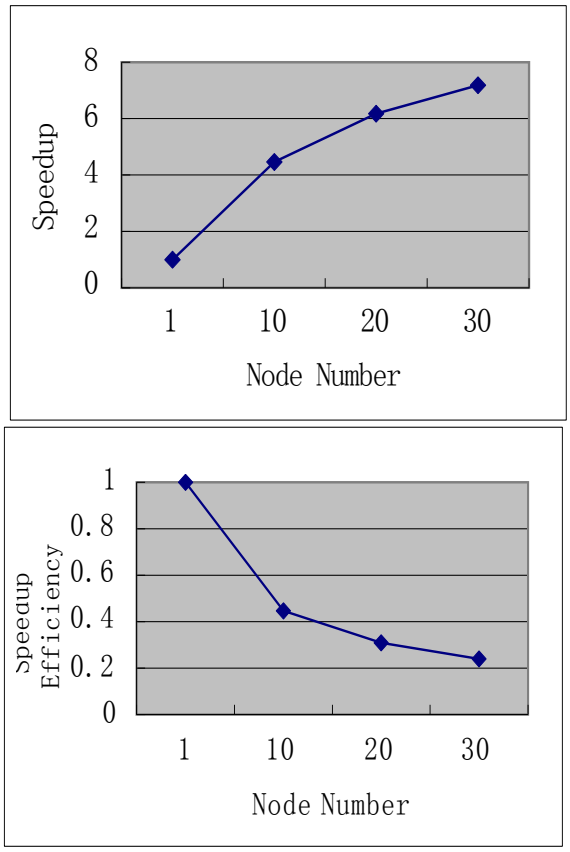

Figure 1. THE SPEEDUP AND SPEEDUP EFFICIENCY OF FOUR LAYER MT DATA PARALLEL INVERSION.

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Solving the Power Purchase Cost Optimization Problem with Improved DE Algorithm

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***Abstract*—Under the deregulation of generation market in China, all distributed generators will particular in electric power bidding. Therefore power purchase cost optimization (PPCO) problem has been getting more attention of power grid Company. However, under the competition principle, they can purchase power from several of power plants, therefor, there exist continuous and integral variables in purchase cost model, which is difficult to solve by classical linear optimization method. An improved differential evolution algorithm is proposed and employed to solve the PPCO problem, which targets on minimum purchase cost, considering the supply and demand balance, generation and transfer capability as constraints. It yields the global optimum solution of the PPCO problem. The numerical results show that the proposed algorithm can solve the PPCO problem and saves the costs of power purchase. It has a widely practical value of application.**

Keywords-Power market; Power purchase cost optimization; Improved Differential Evolution; Adaptive parameter

I. INTRODUCTION

With the implementation of separating the power plants from grid company and generation bidding in power market in China, it is important for the grid company to optimize the purchasing schedule to reduce the cost of grid company[1-3].

According to the different settlement rules, the objective function of generation-side electricity market is divided to two classes. One is to minimum the cost based on the unified marginal settlement, while the other is minimum cost based on the practical generators bidding[4,5]. The second power purchase cost optimization(PPCO) problem is studied in this paper. The PPCO problem is studied for some years. DUAN established a purchase optimization model considering the generation capability and line loss, and solved this model by penalty function [1]. But he only discussed the PPCO problem on the protection and coordination principle. CHEN et al. established purchase optimization model on the market principle and solved it by Lagrange relaxation method [4]. TAN et al. discussed the multilevel purchase optimization model of long-term, mid-term and short-term electricity market and analyzed the relationship of them, but they did not give the solution method [6]. ZHANG et al. established a purchase optimization model with the constraint of supply and demand balance and constraint of generation capability. They solved this model by the PSO but they did not consider the transfer capability constraint and did not satisfy the constraint of supply and demand balance [2]. ZHANG et al. established a purchase optimization model with the constraints of supply and demand balance, generation capability and transfer capability. They solved it with PSO and obtain a satisfied solution [3].

Differential Evolution (DE) algorithm[7,8] is a heuristic global search method which has been employed in many fields such as chemical industry, machine design, information processing, biological information, geophysical inversion[9,10,11]. The DE algorithm has employed to solve the PPCO problem recently, but did not consider the constraints of transfer capability and supply and demand balance [12].

The purchase optimization model is established with the constraint of the supply and demand balance, generation capability, and transfer capability firstly. And an improved DE algorithm with the dynastic mutation factor and crossover factor is proposed secondly. Then the steps of algorithm for the PPCO problem based on the improved DE algorithm thirdly, and the correctness of the proposed algorithm is verified by numerical experiment.

II. POWER PURCHASE MODEL

The goal of power purchase optimization is to minimum the cost of purchasing particular quantity of electricity considering some constraints.

The power purchase cost optimization problem can be modeled as follow:

$$
\begin{aligned}
& MinF,\ F=\sum_{i=1}^{n} C_i P_i \\
& \text{S.T.} \quad \sum_{i=1}^{n}(1-\Delta P_i)P_i = P_d \\
& \qquad P_i = 0 \ \ or \ \ P_{i\min} \le P_i \le P_{i\max} \\
& \qquad -L_{i\max} \le L_i \le L_{i\max}
\end{aligned}
\tag{1}
$$

where $C_i, P_i, \Delta P_i$ is the electricity price, the purchase quantity of electricity and the line loss of i-th power plant respectively; P_d is the particular quantity of electricity should be purchased; $P_{i\min}$ and $P_{i\max}$ is the minimum and maximum generation capacity of *i*-th power plant respectively; $L_{i\max}$ is the transmission capacity of the line from *i*-th power plant to grid company; *F* is the objective function of power purchase cost optimization.

III. IMPROVED DE ALGORITHM

A. Basic DE algorithm

DE algorithm first initialize is a parallel direct search method which utilizes *NP* *n*-dimensional parameter vectors $X^0 = \left[x_1^0, x_2^0, ..., x_{NP}^0\right]$ as a population for each generation. The initial vector population is chosen randomly and should cover the entire parameter space. Then DE algorithm update population by the operation of mutation, crossover and selection.

(1) Mutation

DE generates new parameter vectors by the operation named mutation which add the weighted difference between two population vectors to a third vector.

$$\boldsymbol{v}_i^{k+1} = \boldsymbol{x}_{r1}^k + F(\boldsymbol{x}_{r2}^k - \boldsymbol{x}_{r3}^k) \tag{2}$$

where $x_i^k = (x_{i1}^k, x_{i2}^k, ..., x_{iD}^k)$ is the *i*-th vector of *k*-th generation, $r_1, r_2, r_3 \in \{1, 2, ..., NP\}$, $r_1 \neq r_2 \neq r_3 \neq i$, $F > 0$ is the mutation factor.

(2) Crossover

In order to increase the diversity of the perturbed parameter vectors, crossover is introduced as follow.

$$\boldsymbol{u}_{ij}^{k+1} = \begin{cases} \boldsymbol{v}_{ij}^{k+1}, rand(ij) \leq CR \text{ or } j = rand(j); \\ \boldsymbol{x}_{ij}^k, rand(ij) > CR \text{ or } j \neq rand(j); \end{cases} \tag{3}$$

where $rand(ij)$ is a uniform random number generator with outcome $rand(ij) \in [0,1]$; *CR* is crossover factor $CR \in [0,1]$ which has to be determined by the user; $rand(j)$ is a randomly chosen index $rand(j) \in 1, 2, ..., D$, which ensures that $\boldsymbol{u}_{ij}^{k+1}$ gets at least one parameter from $\boldsymbol{v}_{ij}^{k+1}$.

(3) Selection

To decide whether or not the $\boldsymbol{u}_{ij}^{k+1}$ should become a member of generation $k+1$, it is compared to the $\boldsymbol{x}_{ij}^k$ using the greedy criterion as follow.

$$\boldsymbol{x}_i^{k+1} = \begin{cases} \boldsymbol{u}_i^{k+1}, f(\boldsymbol{u}_i^{k+1}) < f(\boldsymbol{x}_i^k); \\ \boldsymbol{x}_i^k, \quad Otherwise. \end{cases} \tag{4}$$

If the algorithm convergence or the max iteration is achieved, algorithm finish, otherwise, begin the next iteration of mutation, crossover and selection.

B. Improved DE Algorithm

The mutation factor *F* and crossover factor *CR* is critical to the performance of basic DE algorithm. The large *F* and *CR* is beneficial to the global search ability, but it is harmful to the local search ability leading to the poor convergency speed, and vice versa. So we improve the DE algorithm in the following ways.

(1) Adaptive mutation factor

The following adaptive mutation factor is introduced in order to improve the global search ability at the early stage and the local search ability at the later stage of the algorithm.

$$F = F_{\max} - \frac{t(F_{\max} - F_{\min})}{T_{\max}} \tag{5}$$

(2) Increasing crossover factor

DENG and RAN [13] propose the following strategy of increasing crossover factor to achieve the balance between global search ability at the early stage and local search ability in the later stage of the algorithm.

$$CR = (CR_{\min} - CR_{\max})[(\frac{t}{T_{\max}})^2 - 2\frac{t}{T_{\max}} + 1] + CR_{\max} \tag{6}$$

(3) Random mutation

In order to avoid the stagnation of DE algorithm at its last stage, a random mutation method is introduce. If an individual are stagnated in certain iterations, a random mutation is happen in this individual, that is random initializing a individual to replace the stagnated one. The random mutation method is described as follow:

$$\begin{aligned} &if \quad F(x_i^t) = F(x_i^{t+1}) = F(x_i^{t+2}) = \cdots = F(x_i^{t+p}) \, and \, F(x_i^t) \neq F^* \\ &then \; x_i^{t+p+1} = x_{\min} + rand(0,1) * (x_{\max} - x_{\min}) \end{aligned} \tag{7}$$

Where F^* is fitness of global best individual, p is max stagnation iteration allowed, $(x_{\min}, x_{\max})$ is the random search space.

We define the improved DE algorithm, which employ the adaptive mutation factor and increasing crossover factor strategy, named as DE1. And we define the improved DE algorithm, which employ the adaptive mutation factor, increasing crossover factor, and random mutation strategy, named as DE2.

IV. SOLVING THE PPCO PROBLEM WITH IMPROVED DE ALGORITHM

A. *Strategy for the constraints*

The generation and transfer capacity constraints are transformed to boundaries of parameter vector. The balance of supply and demand constraints is considered using the penalty function method and the PPCO problem is transformed from a optimization problem with constraints to a non-constraint optimization problem. The objective function is following:

$$MinF,\ F=\sum_{i=1}^{n}C_iP_i+\alpha\left[\sum_{i=1}^{l}(1-\Delta P_i)P-P_{\exp ect}\right], \tag{8}$$

where $P_{\exp ect}$ is the particular power should be purchased; α is penalty factor; the variables be optimized P_i, is the power purchased from *i*-th power plant.

B. *Algorithm steps of improved DE for PPCO*

The algorithm steps of improved DE for PPCO problem are following:

Step 1: given the upper and lower boundaries of the variables be optimized P_i, the population *NP*, the upper and lower boundaries of mutation factor *F* and crossover factor *CR*;

Step 2: initialize the population of parameter vector randomly according to the upper and lower boundaries of P_i;

Step 3: calculate the objective function value of P_i, according to formula (8);

Step 4: execute the mutation, crossover and selection according to formula (2),(3),(4) respectively, and obtain the next generation population $[\boldsymbol{x}_1^{k+1},\boldsymbol{x}_2^{k+1},...,\boldsymbol{x}_{NP}^{k+1}]$;

Step 5: update the mutation factor and crossover factor according to the formula (5),(6);

Step 6: if the algorithm stagnate certain iterations, random mutation a individual according to the formula (7);

Step 7: calculate the objective function value of P_i, according to formula (8);

Step 8: if the convergency and the max iteration is not achieved, go to step 4, begin next iteration;

Step 9: output the solution, finish.

V. NUMERICAL RESULT AND ANALYSIS

A. *Benchmark Results*

We use following five benchmark functions to test our improved DE algorithm.

(1) Sphere

$$f_1(x)=\sum_{i=1}^{n}x_i^2,\quad n=30,|x_i|\le 100 \tag{9}$$

(2)Generalized Schwefel's

$$f_2(x)=\sum_{i=1}^{n}(x_i\sin(\sqrt{|x_i|})),\ n=30,|x_i|\le 500 \tag{10}$$

(3)Rastrigr

$$f_3(x)=\sum_{i=1}^{n}[x_i^2-10\cos(2\pi x_i)+10],\ n=30,|x_i|\le 32 \tag{11}$$

(4)Griewank

$$f_4(x)=\frac{1}{4000}\sum_{i=1}^{n}x_i^2-\prod_{i=1}^{n}\cos(\frac{x_i}{\sqrt{i}})=1,\ n=30,|x_i|\le 600 \tag{12}$$

(5)Ackly

$$f_5(x)=-20\exp[-0.2\sqrt{\frac{1}{n}\sum_{i=1}^{n}x_i^2}]-\exp\left(\frac{1}{n}\sum_{i=1}^{n}\cos(2\pi x_i)\right)+20+e$$

$$,\ n=30,|x_i|\le 5.12 \tag{13}$$

The parameters of standard DE algorithm are set as follows: $CR=0.9,F=0.5$. The Parameters of improved DE algorithm are set as follows: $CR_{\min}=0.1,CR_{\max}=0.9,$ $F_{\min}=0.3,F_{\max}=1.2$. Both algorithms' number of individuals are 60, max iteration are 2000. The test results are listed in the table 1.

TABLE 1. Benchmark on DE and improved DE algorithm

		f_1	f_2	f_3	f_4	f_5
DE	Average	6.47e-31	-9.74e+3	102.02	7.40e-4	5.51e-15
	Stand. dev.	1.33e-39	900.94	35.19	0.0022	1.63e-15
	Best	1.51e-32	-1.12e+4	10.94	0	4.45e-15
	Worst	7.34e-30	-7.43e+3	183.66	0.0074	7.99e-15
	Runtime	85.92	131.89	107.17	118.06	97.97
Improved DE(DE1)	Average	4.98e-5	-1.26e+4	3.32e-5	1.77e04	0.0015
	Stand. dev.	9.42e-5	2.30e+4	5.59e-5	2.29e-4	0.0014
	Best	7.66e-8	-1.26e+4	8.63e-9	8.39e-8	8.85e-5
	Worst	2.43e-4	-1.26e+4	3.08e-4	8.67e-4	0.0055
	Runtime	262.24	260.94	278.27	279.52	284.47
Improved DE(DE2)	Average	4.13e-5	-1.26e+4	1.67e-5	8.23e-05	0.0012
	Stand. dev.	6.81e-5	12.4e-4	6.95e-5	1.34e-4	0.0013

	Best	9.61e-12	-1.26e+4	7.59e-10	2.02e-8	2.14e-5
	Worst	4.72e-4	-1.26e+4	3.01e-4	4.89e-4	0.0050
	Runtime	290.94	274.67	279.70	323.17	267.74

The results listed in table 1 indicate that the both DE1 and DE2 can improve the accuracy of fitness of benchmark functions, while DE2 is better than DE1 at small degree.

B. PPCO Results

The problem of grid company purchases 200GWh power from 5 power plant is considered. The model of power supply is illustrated as Figure 1.

There is a backup line between plant 2 and 3, which is opened normally. When the line between plant 2 and grid company or between plant 3 to grid is broken, the backup line is closed and the plant 2 and plant 3 share one line to transfer the power. The line loss of the backup line between plant 2 and plant 3 is 0.002.

The emulation program is written using Matlab m language. The parameters are chosen as following: D=5, NP =40, $F_{\min}=0.3, F_{\max}=1.2$, $CR_{\min}=0.1, CR_{\max}=0.9$, max iteration is 5000. The price, line loss, generation and transfer capability are listed in table 2.

Under the normal condition, that means the transfer capability is larger than the generation capability. The results of purchase optimization under the protection and coordination principle are listed in the table 3, compared with the results of literature [2][3][4]. The results show that the cost of our algorithm is same as that of literature [3], but larger than those of the literature [2][3] slightly, because the results of ours and literature [3] is obtained under the constraint of supply and demand balance restrictively whereas those of literature [2][4] is obtained with some deviation of it.

The results of purchase optimization under the normal condition and marketing principle are listed in the table 4, compared with the results of literature [2][3][4]. The results show that the cost of our algorithm is same as those of literature [3][4] which are satisfied with the constraint of supply and demand balance restrictively, while the result of literature [2] is not satisfied that constraint restrictively.

When the line between plant 3 and grid company is broken, the backup line between plant 2 and 3 is close and the two plants share one transfer line between plant 2 and grid company. The results of purchase optimization under such the abnormal condition are listed in the table 5. The optimization results are same as those of literature [3]. Under the protection and coordination principle is 27.6789 million Yuan(￥), and under the marketing principle is 27.3541 million Yuan(￥) .

The numerical results show that the proposed improved DE algorithm has the advantage of fine global optimize ability. It can be employed to solve the PPCO problem and reduce the purchase cost obviously.

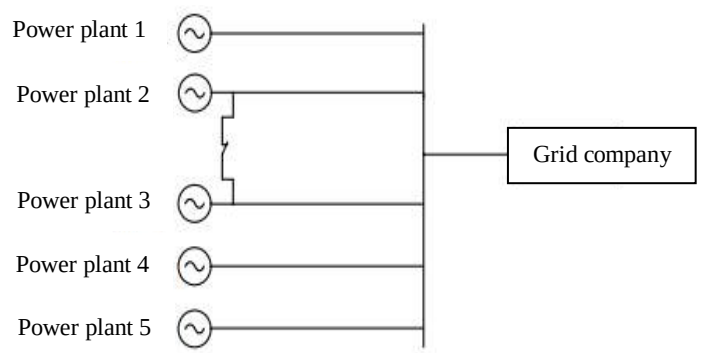

Fig. 1. power supply model of 5 power plants

TABLE 2. Parameters of power supply model of 5 power plants

	C_i (￥/kWh)	ΔP_i	$P_{i\min}/GWh$	$P_{i\max}/GWh$	$L_{i\max}/GWh$
plant 1	0.10	0.0882	43.2	86.4	100
plant 2	0.12	0.0722	21.6	64.8	90
plant 3	0.15	0.0451	21.6	43.2	60
plant 4	0.18	0.0422	14.4	43.2	60
plant 5	0.20	0.0554	14.4	28.8	40

TABLE 3. The results of power purchase optimization under the protection and coordination principle

	literature[2]	literature[3]	literature[4]	our results
plant 1	86.4000	86.4000	86.3979	86.4000
plant 2	64.8000	64.8000	64.6384	64.8000
plant 3	35.2963	35.6356	35.2467	35.6356
plant 4	14.4000	14.4000	14.5145	14.4000
plant 5	14.4000	14.4000	14.4549	14.4000
cost/million ￥	27.1825	27.2333	27.19498	27.2333
supply/demand balance	199.6760	200.0000	199.6391	200.0000

TABLE 4. The results of power purchase optimization under the marketing principle

	literature[2]	literature [3]	literature[4]	our results
plant 1	86.4000	86.4000	86.4000	86.4000
plant 2	64.8000	64.8000	64.8000	64.8000
plant 3	43.2000	43.2000	43.2000	43.2000
plant 4	20.7218	21.0601	21.0601	21.0601
plant 5	0.0000	0.0000	0.0000	0.0000
cost/million ￥	26.6269	26.6868	26.6868	26.6868
Supply/demand balance	199.6760	200.0000	200.0000	200.0000

TABLE 5. The results of power purchase optimization under the abnormal condition

	literature [3]		our results	
	protection and coordination principle	marketing principle	protection and coordination principle	marketing principle
plant 1	86.4000	86.4000	86.4000	86.4000
plant 2	64.8000	64.8000	64.8000	64.8000
plant 3	25.2000	25.2000	25.2000	25.2000
plant 4	25.5659	39.7675	25.5659	39.7675
plant 5	14.4000	0.0000	14.4000	0.0000
cost/million ￥	27.6779	27.3541	27.6779	27.3541
Supply/demand balance	200.0000	200.0000	200.0000	200.0000

VI. CONCLUSION

An improved DE algorithm, which introduce new update method of mutation and crossover factor to improve the balance between the fine global search ability at the early stage and the fine local search ability at the later stage, is employed to solve the power purchase cost optimization (PPCO) problem with generation and transfer capability constraints. The results of five plants power supply model show that the proposed algorithm can find the global optimum of this PPCO problem and reduce the purchase cost obviously. It has a widely practical value of application.

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Detection and Tracking of Objects: A Detailed Study

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***Abstract*—Detecting and tracking objects are the most widespread and challenging tasks that a surveillance system must achieve to determine expressive events and activities, and automatically interpret and recover video content. An object can be a queue of people, a human, a head or a face. The goal of this article is to state the Detecting and tracking methods, classify them into different categories, and identify new trends, we introduce main trends and provide method to give a perception to fundamental ideas as well as to show their limitations in the object detection and tracking for more effective video analytics.**

Keywords-Detection, tracking, representations, descriptors, features.

I. INTRODUCTION

A visual surveillance environment attempts to detect, track, and identify objects from various videos, and usually to understand object behaviors and activities. For example, its purposes to automatically compute the flux of things at public areas such as stores and travel sites, and then accomplish congestion and analysis to support in track organization and targeted advertisement. Such systems would substitute the old-style surveillance setups where the number of cameras beats the capacity of costly human operators to monitor them.

Proceeding with a feature to high-level incident understanding method, there are three main steps of visual analytics: detection of objects [1], tracking of such objects and pointers from frame to frame, and estimating tracking results to describe and conclude semantic events and hidden phenomena. This analogical be extended to other applications with motion-based recognition, access control, video indexing, human and computer communication, and track monitoring and navigation. This paper reviews important characteristics of the detection and tracking steps to support a deeper appreciation of many applications. Suppose you are waiting for your turn in a shopping line at a busy store. You can simply sense humans and classify deferent things of their interactions. As with other tasks that our brain does simply, visual analytics has turned long out to be entwined for machines. Not amazingly, this is also a problem for visual insight. The main challenge is the problem of changeability. A visual detection and tracking system requirements to simplify across vast variations in object presence such due for a case to lookout, posture, facial expressions, lighting conditions, imaging quality or occlusions while preserving specificity to not claim everything it sees are objects of attention. In addition, these tasks should preferably be performed in real-time on conservative computing stages. In detection, motion changes and appearance signs can be used to differentiate objects, which classically reduces it quite easily, and tracking techniques are often activated by detection results. Grouping of statistical analysis of visual features and time-based motion information typically lead to more robust styles. For those systems which face noisy environments, however, tracking is recommended to be tracked by detection to gather sufficient statistic as sufficient track-before-detect algorithms propose. Also, tracking direct to choose detection areas, source and sink areas. In any case, it has been common in the past few years, to accept that deferent approaches are required for these deferent tasks. Here we take the hypothetical view that detection and tracking, rather than being two distinct tasks, represent two points in a spectrum of generalization levels [2].

II. OBJECT DETECTION

Object detection includes detecting instances of objects from a specific class in any image. The aim of object detection is to detect all instances of objects from a known class, such as cars, people or faces in any image. Typically, only a small number of instances of the object exist in the image, but there are many numbers of possible scenes and scales at which they can occur and that need to somehow be explored. Each detection is described with some form of posture information. This could be as simple as the location of the object, or the extent of the object defined in terms of a bounding box. In other conditions, the posture information is more detailed and covers the parameters of a linear or non-linear transformation. For example, a face detector may compute the locations of the eyes, nose and mouth, in addition to the bounding box of the face. The posture could also be defined by a three-dimensional transformation postulating the location of the object comparative to the camera.

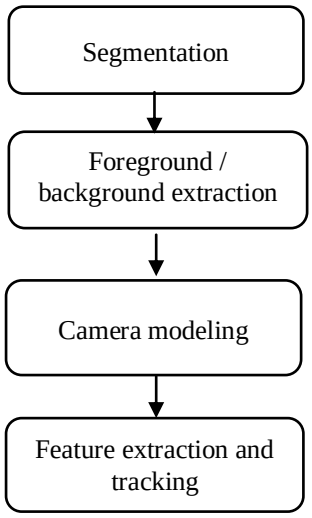
III. Object Tracking

Object tracking is defined as the procedure of segmenting an object from a video section and track its movement, direction, obstruction etc. to extract useful information [3].

Object tracking in video surveillance follows the separation step and is equivalent to the 'recognition' step in the image processing. Detection of moving objects in video streams is the first appropriate step of information abstraction in many computer vision applications, including traffic monitoring, remote video surveillance, and people tracking. There are fundamentally three approaches in object tracking. Feature based methods aim at extracting features such as points, line sectors from image sequences, tracking phase is then confirmed by a matching process at every time instant. Differential methods are based on the optical flow calculation, i.e. on the apparent gesture in image sequences, under some regularization expectations. The third class uses the relationship to measure temporary time of life shifts. Selection of an approach mainly depends on the domain of the problem.

Steps in object tracking

The object tracking process is summarized in the block diagram given below:



Basic steps in object tracking can be listed as:

- Segmentation

Segmentation is the procedure of finding components of the image. Segmentation includes procedures such as boundary detection, connected element labeling, thresholding etc

- Foreground / background extraction

This is the procedure of separating the foreground and background of the image. It is expected that foreground holds the objects of interest. In this method, we use subtraction of images to find objects that are moving and those that are not.

- Camera modeling

Camera model is a significant aspect of any object-tracking algorithm. The all present objects tracking systems use a camera model. In words camera model is directly derived from the domain knowledge.

- Feature extraction and tracking

The next step is to extract useful features from the sequence of frames. Depending on the algorithm, definition of 'feature' may vary.

IV. Object Detection and Tracking Approaches Object Tracking

A. *Feature-based object detection*

Feature-based object detection contains correction of image structures and registering of mention points. The images may require to be changed to additional space for control modifications in clarity, size and arrangement. One or more types are removed and the objects of importance are modeled in terms of these types. Object detection and appreciation can be then changed into a chart similar problematic.

- Shape-based approaches

Shape-based object detection [4] is the solidest problems due to the trouble of segmenting objects of attention in the images. To sense and control the edge of an object, an image may must to be preprocessed. The preprocessing procedure or filter depends on the application. Changed object types such as publics, cars, and aircraft can need changed processes. For extra multipart units, sound deduction and exchanges invariant to scales and spin may be wanted. When the object is sensed and placed, its border can be found by edge finding and boundary-following processes.

- Color-based approaches

Different many other image types (e.g. shape) shade is comparatively constant below lookout changes and it is simply to be developed. Even if color is not at all times fit as the only means of sensing and tracking objects, but the small computational rate of the processes planned makes color a necessary feature to achievement when proper.

B. *Template-based object detection*

If a template relating an exact object is available, object detection becomes a procedure of similar types between the template and the image order in study. Object detection with an exact equal is normally computationally expensive and the quality of similar depends on the specifics and the degree of accuracy providing by the object template. There are dual types of object template same, stable and deformable template matching [6][5].

- Fixed template matching

Fixed templates are beneficial when object profiles do not variation with respect to the watching direction of the camera. Dual main techniques have been used in fix template matching.

Here technique, the template location is resolute from minimizing the space function between the template and many locations in the image.

Correspondence

Similar by correspondence uses the location of the normalized cross-correlation top between a template and an image to find the best match. This technique is normally immune to sound and lighting possessions in the images.

- Deformable template matching

Deformable template matching methods are other proper for cases where objects due to rigid and non-rigid bend. These dissimilarities can be produced by each the deformation of the object or just by different object position relation to the camera. Because of the deformable behavior of objects in maximum video, deformable models are other attractive in tracing tasks.

In this method [7], a template is denoted as a bitmap describing the specific outline/edges of an object figure. A probabilistic alteration on the prototype outline is applied to deform the template to set salient edges in the input image. An objective function with transformation limitations which correct the shape of the template is formulated imitating the cost of such transformations. The best main application of deformable template matching techniques is motion detection of objects in video edges.

C. Motion detection

Detecting moving objects, or motion detection, visibly has very important meaning in video object detection and tracking. A great quantity of research struggles of object detection and tracking absorbed on this problematic in last period. Equaled with object detection without motion, on single hand, motion detection complicates the object detection difficult by addition objects temporal modification requests, on the other hand, it also offers additional info source for detection and tracking.

A great variation of motion detection algorithms has been proposed. They can be categorized into the following sets almost.

- Thresholding technique over the interface difference

These methods depend on the detection of temporal variations either at pixel or block level. The difference map is usually binaries using a predefined beginning value to obtain the motion/no-motion organization.

- Statistical tests constrained to pixel wise independent decisions

These tests accept basically that the detection of temporal changes is equal to the motion detection. But, this assumption is legal when either large displacement appears or the object estimates are suitably textured, but be unsuccessful in the case of moving objects that preserve uniform regions. To duck this limitation, temporal change detection masks and filters have also been measured. The usage of these masks increases the efficiency of the change detection processes, especially in the case where various a priori information about the size of the moving objects is available, since it can be used to define the type and the size of the masks.

- Global energy frameworks

The motion detection problematic is formulated to minimalize a global objective function and is generally done using stochastic (Mean-field, Simulated Annealing) or deterministic reduction processes (Iterated Restricted Modes, Highest Confidence First). In that way, the spatial Markov Random Arenas have been widely used and motion detection has been measured as an arithmetical estimate problem. While this estimate is a very powerful, usually it is very time consuming.

V. THE TYPICAL KALMAN FILTER

The Kalman filter has widely used in engineering application. The Kalman filter has two characteristics. One is its mathematical model; it is described in terms of state-space concepts. The other is that its solution is computed recursively. Usually, the Kalman filter is described by system state model and measurement model.

The state-space model is described as

System state model: $s(t) = \ddot{o}(t-1)s(t-1) + \omega(t)$ (1)

and

Measurement model:

$z(t) = H(t)s(t) + v(t)$ (2)

where $\ddot{o}(t-1)$ and H(t) are the state transition matrix and measurement matrix respectively. The $\omega(t)$ and $v(t)$ are white Gaussian noise with zero mean and

$E\{w(k)w^T\} = Q\delta_{kl}$,

$E\{v(k)v^T\} = R\delta_{kl}$,

whereδ_{kl} denotes the Kronecker delta function [8]; Q and R are covariance matrices of $w(t)$ and $v(t)$, respectively.

The state vector $s(t)$ of the current time t is predicted from the previous estimate and the new measurement $z(t)$.

The tasks of the Kalman filter have two phases: prediction step and correction step. The prediction step is responsible for projecting forward the current state, obtaining a priori estimate of the state $s^-(t)$. The task of correction step is for the feedback. It incorporates an actual measurement into the a priori estimate to obtain an improved a posteriori estimate $s^+(t)$. The $s^+(t)$ is written as

$$s^+(t) = s^-(t) + K(t)\big(z(t) - H(t)\, s^-(t)\big), \quad (4)$$

where $K(t)$ is the weighting and is described as

$$K(t) = P(t)^{-}H(t)^{T}\left(H(t)P^{-}(t)H(t)^{T} + R(t)\right)^{-1}$$

$$= \frac{P(t)^{-}H(t)^{T}}{\left(H(t)P^{-}(t)H(t)^{T} + R(t)\right)} \quad (5)$$

In Eq. (10), the $P(t)^{-}$ is the priori estimate error covariance. It is defined as

$$P^{-}(t) = E[e^{-}(t)e^{-}(t)^{T}]$$

Where $e^{-}(t) = s(t) - s^{-}(t)$ t) is the priori estimate error. In addition, the posteriori estimate error covariance $P^{+}(t)$ is defined as

$$P^{+}(t) = E[e^{+}(t)e^{+}(t)^{T}]$$

where$e^{+}(t) \equiv s(t) - s^{+}(t)$ is the posteriori estimate error.

VI. Kernal Based Mean Algorithm

Mean shift is a non-parametric statistical method which was introduced for object tracking applications. To characterize the target, first a feature space is chosen. Then reference target model is represented by its probability density function (PDF) in the feature space. Similarly, a candidate model is represented with PDF function. A similarity density is calculated between the target model and candidate model to match the maximum likeness with the help of Bhattacharya coefficient ρ [p(x), q]. For example, the reference model can be chosen to be the color PDF of the target. [10] Without loss of generality, the target model can be considered as cantered at the spatial location 0. In the subsequent frame, a target candidate is defined at location y, and is characterized by the PDF p(y). Both PDFs are to be estimated from the data.

VII. Mean Shift Algorithm

Mean shift algorithm for moving object tracking was initially proposed in the estimation of Probability density function. Mean shift algorithm iteratively shifts a data point to the average of data point in its neighborhood. If we have distribution points. Then according to the mean shift algorithm modes or Peaks in density function is determined. This method is called non-parametric method this method of tracking tracks the object for long time and more robust compare to other tracking algorithm. To find the new location of the object that we are going to track, we need to find a vector which can suggest the direction of the moving object. This vector [11] is called mean shift vector First we need to draw the ROI around the object and get the data points, approximate location of the mean of this data. Then estimate the exact location of the mean of the data by determining the mean shift vector from the initial mean.

- In the first frame, tracking object is selected and object model has probability distribution of colour

Histogram [9]. If $y0$ is the centre of an object, then the position of pixels are $\{x *_i\}\ i = 1 \ldots N$, where N is the number of pixels in the image. statistical histogram distribution model of target area given by

$$q_h = C \sum_{I=1}^{n} k\left(||x_i||2\right)\delta[b(x_i^{*} - h)] \quad (6)$$

- At the current frame, the statistical histogram distribution given by

$$\widehat{p_h}(y_0) = C_h \sum_{i=1}^{nh} k(||\frac{y_0 - x_i}{w})\delta[b(x_i) - h] \quad (7)$$

(1)

- Computing the measurement between the object and candidate template by Bhattacharyya coefficient.

$$P(\widehat{p_h}(y_0), \widehat{q_h}) = \sum_{h=0}^{H-1} \sqrt{p_h(\widehat{y_0})\widehat{q_h}}$$

- Weight of the window of pixels in tracking window

$$w_i = \sum_{h=0}^{H-1} \delta[b(x_i) - h]\sqrt{\frac{\widehat{q_h}}{\widehat{q_h(y_0)}}}$$

- New object position search by mean shift value given by

$$y_i = \frac{\sum_{i=0}^{nh} x_i\, w_i g(|\left|\frac{y_0 - x_1}{W}\right| 2|\ )}{\sum_{i=0}^{nh} w_i\, g(|\left|\frac{y_0 - x_1}{W}\right| |2\ )}$$

Then computing the Bhattacharya coefficient given by

$$P(P_h(\widehat{y_1}), \hat{q}) = \sum_{h=0}^{H-1} \sqrt{\widehat{q_h}}\,(y_1)\widehat{q_h}$$

- Comparing coefficients and update the candidate window.
- If $||y1 - y0\ || < \varepsilon$ iteration stops, and going to step 2.

VIII. SIFT Algorithm

Scale-invariant feature transform (or SIFT) is an algorithm in computer vision to detect and describe local features in images. This algorithm was published by David

Lowe. The SIFT algorithm can identify two objects as similar even the object is partly concealed in either one of the images has changed orientation, or the object is viewed at different angles.

The SIFT algorithm has split into four main phases such as,

A. *Extrema Detection*

The first phase inspects the image under various scales and octaves to separate points of the picture that are different from their backgrounds. These points are called extrema which is the potential candidates for image features.

B. *Key point Localization*

The Key Point Detection, starts with the extrema and selects some points to be key points, that are a whittled down a set of feature candidates. This refinement rejects extrema, which are caused by edges of the picture and by low contrast points.

C. *Orientation Assignment*

Each key point and its neighborhood are converted into a set of vectors by computing a magnitude and a direction for them. It also identifies other key points that may have been missed in the first two phases; this is done based on a point having a significant magnitude. The algorithm now has identified a final set of key points.

D. *Key point Descriptor Generation*

Key point Descriptor Generation, takes a collection of vectors in the neighborhood of each key point and consolidates this information into a set of eight vectors called the descriptor. Each descriptor is transformed into a feature by computing a normalized sum of these vectors.

CONCLUSION

In this paper, we researched various filters for image tracking and found that the use of Kalman filter shows better results. The effectiveness and robustness have been proved.

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Model-Driven Generation of MVC2 Web Applications: From Models to Code

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***Abstract*—Computer systems engineering is based, increasingly, on models. These models permit to describe the systems under development and their environment at different abstraction levels. These abstractions allow us to conceive applications independently of target platforms. For a long time, models have only constituted a help for human users, allow to manually develop the final code of computer applications. The Model-Driven Engineering approach (MDE) consists of programming at the level of models, represented as an instance of a meta-model, and using them for generating the end code of applications. The MDA (Model-Driven Architecture) is a typical model-driven engineering approach to application design. MDA is based on the UML standard to define models and on the meta-modeling environment (MOF) [1] for model-level programming and code generation. The code generation operation is the subject of this paper. Thus, in this work, we explain the code generation of MVC2 Web application by using the M2M transformation (ATL transformation language) then the M2T transformation. To implement this latter we use the Acceleo generator which is a generator language. In the M2T transformation, we use the PSM model of Struts2 already generated by M2M transformation as an input model of Acceleo generator. This transformation is validated by a case study. The main goal of this paper is to achieve the end-to-end code generation.**

Keywords- MDA; PSM; Code Generation; Acceleo; Struts; ATL transformation; MVC2 architecture

I. INTRODUCTION

In recent years, development of Internet, distributed, embedded or self-managed applications has considerably complicated the development of computer systems. These are used in increasingly varied and constrained environments (mobile terminals, cars, robots) and in increasingly critical contexts (aerospace, medical, military, nuclear). In addition, during their lifetime, software is subject to constant evolution to satisfy user needs and adapt to new platforms. Academic and industrial world are thus led to rethink the software production processes in order to adapt them to these new stakes.

A pragmatic vision to adapt to these changes is to allow the software production in automatic way in order to take into account the inevitable evolutions which these are subjected to. The models have always been used in computer science as a basis for reflection. However, they have often been relegated to the rank of simple documentation. Model-driven engineering aims to place models at the heart of the development process to make them the main elements through which applications are generated. Taking model change into account and automatically generating systems by generation from these models seems to be a promising outcome to meet changing constraints.

At the heart of model-engineering are placed the model transformations. They realize the automation of essential stages of software production: refinement and models composition, reverse engineering, code generation and documentation, etc. These transformations are intended to be used repeatedly by development teams, for example in software workshops. Therefore, it is crucial that they be validated and tested so that the developer can have full confidence in them.

The presented work is the continuation of the work presented in [39]. This work allows generate automatically a MVC2 web application that is a source code of an application based on Struts2 framework [1]. To realize this operation of code generation, we used ACCELEO [37] as a code generation language. To achieve this code generation, we begin by implementing the different templates corresponding to each meta-class which is an element of the PSM model already generated in [39]. After establishing the different templates (Action classes and Jsp pages), we validate the automatic code generation with a case study.

The remaining part of this paper is structured as follows: section 2 explains the process and methodology of this work. Section 3 is devoted to the architecture of UML and Struts2 meta-models. Section 4 is devoted to the transformation rules implementation. Section 5 is dedicated to the transformation rules execution and the result of execution process. Section 6 presents the Model-to-Text transformation implementation. The Model-to-Text transformation result is dedicated to the section 7. Section 8 presents the evaluation of this work. Section 9 discusses the main related work, while section 10 wraps up the conclusions and future works.

II. PROCESS AND METHODOLOGY

In this work, we begin our process by the presentation of the different meta-models (CIM, PIM and PSM). CIM model is represented by an UML class diagram of a case study of an Employee management. This UML class diagram is represented by an Ecore model. The PIM meta-model is an extract of UML class diagram meta-model. The PSM meta-model refers to the Struts2 meta-model. After models and meta-models, we define the different ATL transformation rules. Then, we implement the KM3 models corresponding to each PIM and PSM meta-model then the different Ecore models corresponding to these KM3. The next step is devoted to establish the traceability links between different elements of source and target meta-models and thereafter we define the different transformation rules in ATL transformation language. The ATL transformation result is a MVC2 web model represented in EMF model. In the end step, we use the generated PSM model as an input model of Acceleo generator then we generate the application code of the presented case study by applied a M2T transformation based on the cited ACCELEO generator. In the case of M2T transformation, we begin by the implementation of different templates corresponding to the Action classes and the JSP pages. The work of this transformation is validated and exemplified by a case study.

The tools support of this work is the UML [14], ATL transformation language [22]-[23]-[24], MOF [15], XMI [16], KM3 [6], OCL [17], EMF Project [15] and Acceleo [37].

The following section is dedicated to the M2M transformation based on MDA approach and ATL transformation language [25]. In this section, we begin by presenting the different meta-models.

III. UML AND STRUTS2 META-MODELS

In this section, we explain the different meta-classes that form the UML source and the target meta-models.

A. *UML Source Meta-model*

Figure 1 presents the UML source meta-model. This meta-model is a simplified UML model composed essentially of packages containing the data types and classes. The main elements of this metamodel are:

- UmlPackage: This is an UML package concept.
- Classify: Represents the generalization concept of meta-class. This latter represents both the concept of UML class as well as the data type concept.
- Class: Shows the UML class concept.
- DataType: Explains the concept of UML data types.
- Operation: Represents the concept of UML class methods.
- Parameter: Expresses the method parameters concept.
- Property: Represents the concept of UML class properties.

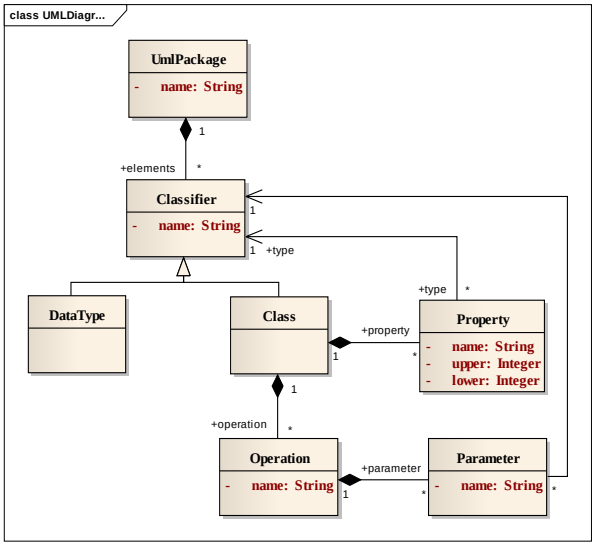

Figure 1. An Extract of UML Class Diagram Metamodel.

B. *Struts 2 Target Meta-model*

In this section, we present the Struts2 target meta-model. This meta-model is explained in first time in [39]. The different elements that form the Struts 2 meta-model are as follows:

- ModelPackage: Presents the concept of UML package. This package designates the notion of Model in the MVC2 architecture.
- ControllerPackage: Expresses the Controller concept in the MVC2 architecture.
- ViewPackage: Indicates the concept of Views package.
- ActionMapper: Represents the ActionMapper class concept.
- ActionProxy: Expresses the ActionProxy class concept.
- ActionInvocation: Expresses the ActionInvocation class concept.
- Action: Indicates the concept of action in the controller package.
- JspPages: Represents the Jsp package concept.
- Result: Expresses the generated element through an Action class.
- The Interceptors: Represents the concept of an Interceptor package.
- Interceptor: Indicates the interceptor classconcept.
- HttpRequest: Expresses the concept of HttpServletRequest class.
- HttpResponse: Designates the concept of HttpServletResponse class.

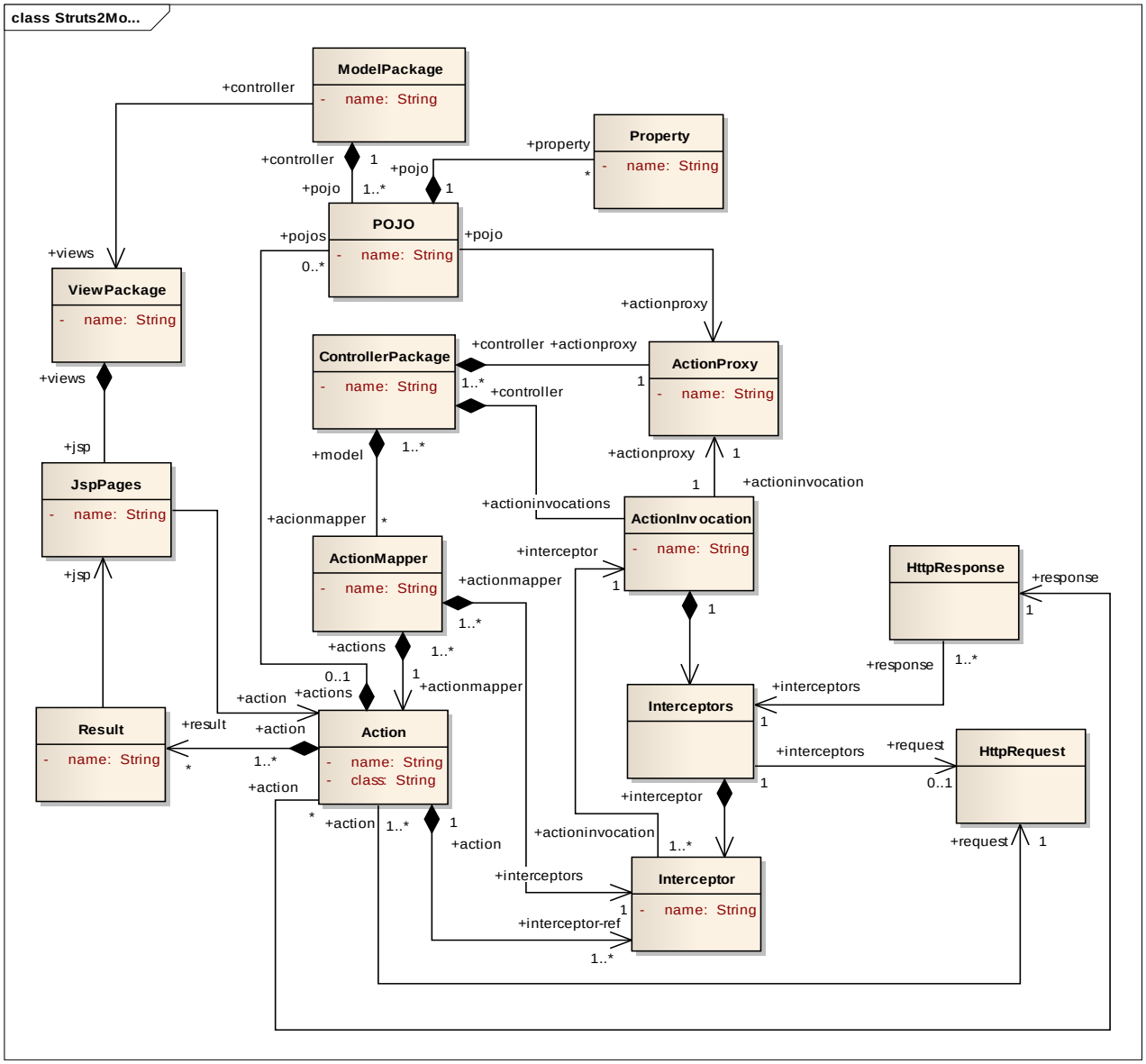

Figure 2. PSM Struts2 Meta-model.

IV. Transformation Rules Implementation

This section is dedicated to the transformation rules implementation. It explains the different steps from implementation to execution of different transformation rules. In first step, we implement the different meta-models like: *struts2.km3*, *struts2.ecore*, *UML.km3* and *UML.ecore*. In second step, we establish the rules specification. Then, we define the different transformation rules based on these specification rules by ATL language in a file named *UML2Struts2.atl*. Finally, we implement the source model. This latter is an UML class diagram of Employee management represented in XMI language.

The different tools permits to achieve this work are: ATL plug-in integrated in Eclipse, XMI, OCL, KM3, UML, MOF and EMF project.

The next section is dedicated to the implementation of rules specification and then the definition and the execution of ATL transformation rules. Ecore and *km3* meta-models are not presented in this paper for letting it quite understandable and clear.

A. Rules Specification

This section is devoted to the presentation of the main rules to transform an UML Class Diagram into Struts2 Web model. The different specification rules are:

- An UML package generates a Struts2 package.
- The Struts package is composed of a Controller package and a View package.
- Each Controller Package is composed of a set of Action classes.
- An Action class is composed of a set of Result classes.
- An Operation generates an Action and a JSP pages.

B. *Rules-Based transformation written in ATL*

This section expresses the different rules which transform the UML class diagram into MVC2 web model. The different rules are:

Rule 1: From Operation to Struts 2 Action

This rule represents the main rule of this transformation. Thus, this rule allows generate the different action classes and Jsp pages of each Action. The name of each jsp page is composed from the name of the operation concatenated with the name of the class and followed by the extension ".jsp". The different rules that compose this main rule are as follow:

- Rule 1: An Operation can generate an Action.
- Rule 2: An Operation can generate a Result.
- Rule 3: Each Result class is composed of a set of Jsp pages.

The main rule is shown in figure 3. These rules are implemented by ATL language.

```
rule Operation2Action{

    from
        c : UML!Operation
    to
      js : NTiers!JspPage (
              name<- if c.name<>'Delete'then
                        c.name+c.class.name+'.jsp'
                     else 'Retrieve'+c.class.name+'.jsp'
                   endif
             ),
      frm : NTiers!Action(
            name<- c.name+c.class.name+'Action',
            method <- c.name+c.class.name,
            class <- 'com.web.struts2.'+c.name+c.class.name+'Action',
            result <- Sequence{fr}
           ),
      fr : NTiers!Result(
            name <- 'Success',
            type <- 'redirect',
            jsp <- js
        )
   }
```

Figure 3. Main Rule : From Operation to Action.

V. TRANSFORMATION RULES EXECUTION

In this section, we present a case study to demonstrate and exemplify our proposition. The UML class diagram of this case study represents the source model of our ATL transformation. The execution algorithm of ATL transformation allows browsing all transformation rules and thereafter generates the MVC2 web model. This latter is represented in figure 6.

A. *Case study*

The current case study is a system of a three classes. This system makes it possible to manage an employee of a given department. The different classes that compose this system are: City class, Department class and Employee class. In this case study, we elaborate only the CRUD operations (Create, Retrieve, Update, and Delete). These operations are most often implemented in all systems. Figure 4 presents the Ecore model equivalent to the UML class diagram of a department's employees.

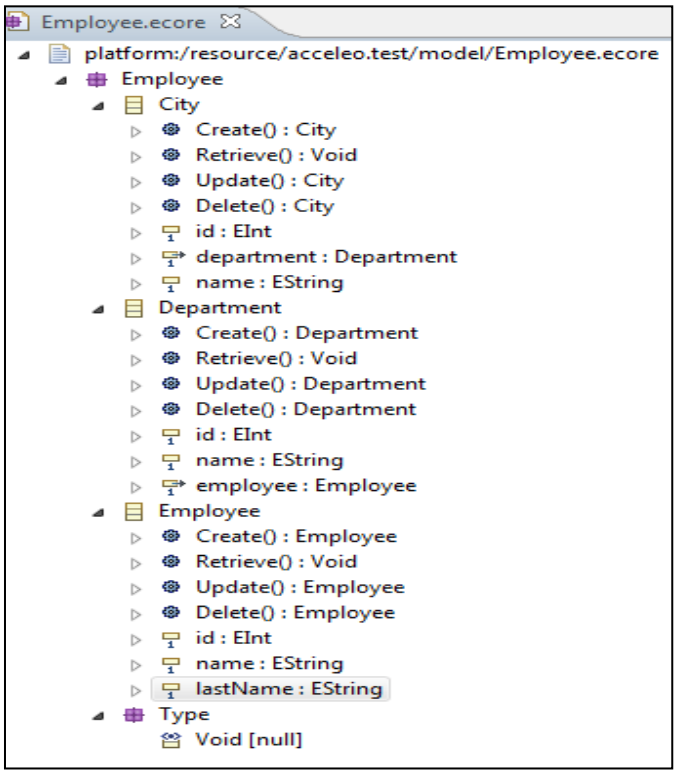

Figure 4. Ecore model of a department's employees.

B. *ATL Transformation Result*

Figure 5 shows the generated MVC2 Web model of Struts2. This model contains the different ingredients for implementing a presentation layer respecting the architecture of MVC2 pattern.

The generated model is composed of a Struts package that is composed of a set of Action classes and the View package that is composed of a set of Jsp pages.

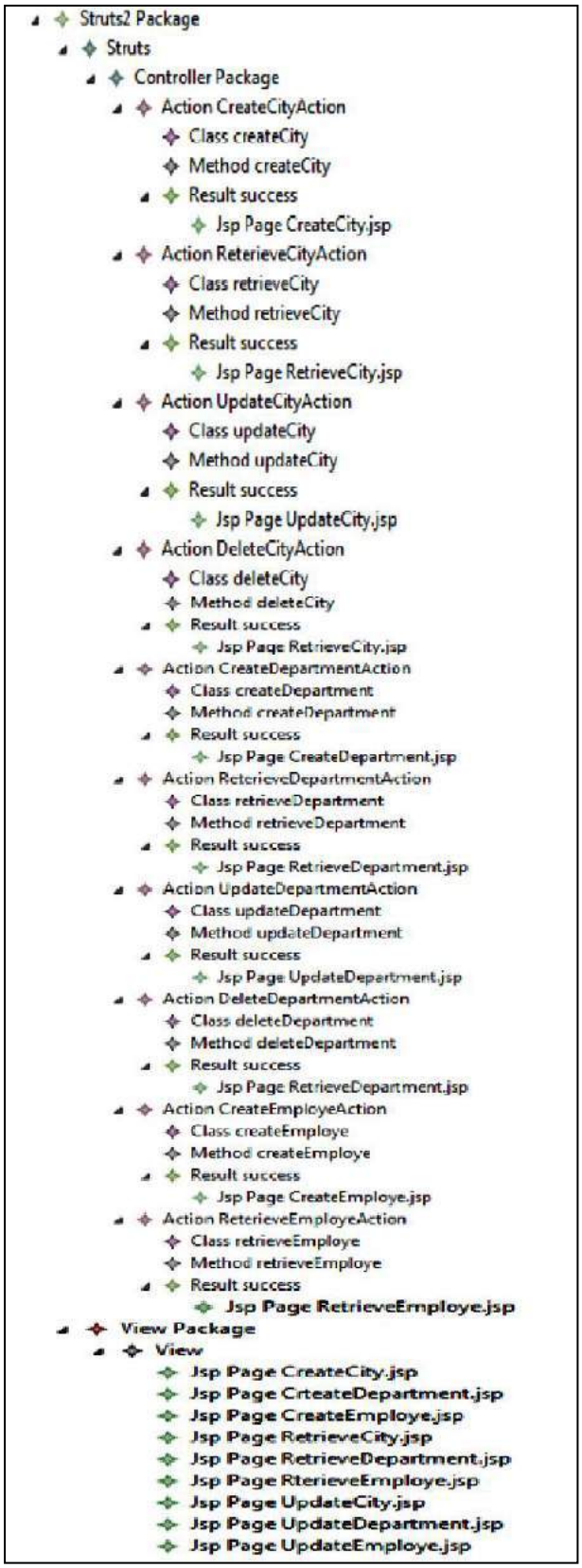

Figure 5. The Generated MVC2 Web model.

VI. Model-To-Text (M2T) Transformation Implementation

In this M2T transformation, we use the Acceleo [37] code generator which is a code generator integrated into Eclipse. The following section gives an idea of this generator then a brief history of this latter.

A. *ACCELEO Generator*

Acceleo [37] is a source code generator of Eclipse foundation that enables the implementation of MDA (Model driven architecture) approach to realize applications from models based on EMF. This is an implementation of the Object Management Group (OMG) standard for model-to-text (M2T) transformations.

The famous Acceleo project was born in 2006 around the Acceleo.org website by Obeo. In its first versions, Acceleo 1.0 and 1.1 were at the time under GPL licence and compatible with Eclipse 3.2 and many modelers based on EMF or UML. In 2009, for his passage to version 3, the project was admitted to the Eclipse Foundation. From this transition, Acceleo changed the language used to define generators to use the standard OMG language for model-to-text transformation. This language is an implementation of the MOFM2T standard. ACCELEO is based on the concept of template approach.

B. *Structure of ACCELEO project*

According to the model already generated shown in figure 6, the ACCELEO structure project is composed of the following principles elements:

- The "*GenerateStruts2*" package 1 presents the different generated classes (Bean and Action classes).
- The "org.eclipse.acceleo.ecore2java.files" package 2 contains the main template explained in figure 8.
- 3 Represents the main template named "*genStruts2.mtl*".
- Represents the main template named "*genStruts2.mtl*".
- 4 Represents the template of Jsp pages.
- The "*GenerateJsp*" folder 5 contains the different JSP pages generated by code generation.

Figure 7 presents the created ACCELEO project and the different packages and templates that constitute this project.

In the following section, we present the different templates necessary to implement the automatic code generation by ACCELEO and then to respond to our case study.

C. *Code Generation Implementation*

In this paper, we present the different templates permits to generate the source code from PSM model (Figure 5) already generated by applying M2M transformation in [39].

The generated PSM model implements only a CRUD application that performs the operations of listing, adding, modifying and deleting on a given entity. This use case is so common in software development that it is rare to find an application that does not do CRUD.

The aim of this paper is to implement the automatic code generation of a Java web application allowing to make CRUD on an entity model (UML class diagram) using Struts2 as a presentation framework.

The automatic code generation by ACCELEO is based necessary on the implementation of templates. In this paper, we implement the templates correspond to the Action classes and Jsp pages. The different templates needed to realize this project are listed in the following UML class diagram shown in figure 7.

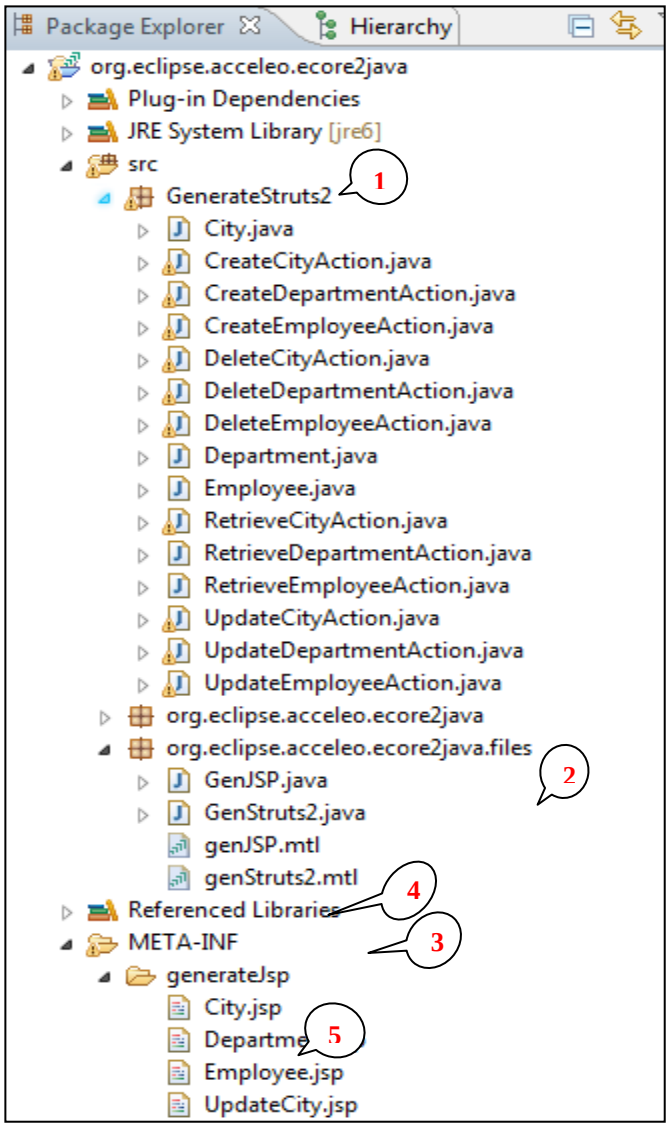

Figure 6. The Structure of Acceleo project.

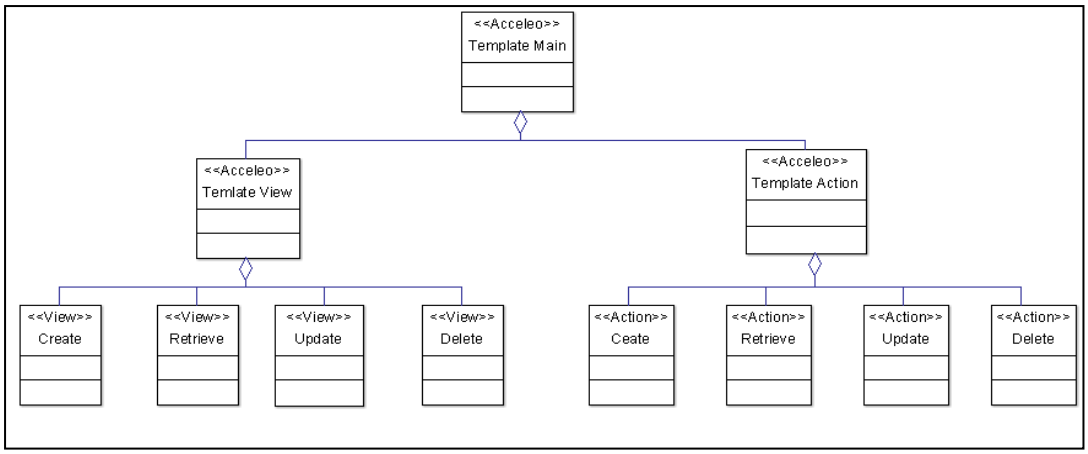

Figure 7. UML class diagram of Main template corresponding to Struts2 Model.

According to the figure 7, the principle templates are as follow: "Template Action" and "Template View". In this section, we begin by implementing the "*Template Action*" then in second hand we implement the "*Template View*".

1) Template of Actions

The different templates which constitute the templates of Actions, according to the figure 7, are as follow:

a) Template of Create Action class

This template permits to generate a Create class Action. This latter allows insert or create a new employee, a new city or a new department. The figure 8 shown below presents this template.

```
[file ('Create'.concat(aEclass.name).concat('Action').concat('.java'), false, 'UTF-8')]
[comment]//CreateAction Class[/comment]

package GenerateStruts2;
import java.sql.DriverManager;
import java.sql.PreparedStatement;
import java.sql.ResultSet;
import com.opensymphony.xwork2.ActionSupport;

public class Create[aEclass.name.toUpperFirst()/]Action extends ActionSupport{
    private static final long serialVersionUID = 1L;

    [aEclass.name/]Bean mb=new [aEclass.name/]Bean();

    public [aEclass.name/]Bean getMb() {
        return mb;
    }
    public void setMb([aEclass.name/]Bean mb) {
        this.mb = mb;
    }


    public String execute()
    {

    try{
    Class.forName("oracle.jdbc.driver.OracleDriver");
    java.sql.Connection con
=DriverManager.getConnection("jdbc:oracle:thin:@localhost:1521:XE","system","admin");

    String s = "insert into [aEclass.name/] values(?,?,?)";
    PreparedStatement ps=con.prepareStatement(s);
    [for (aEAttribute : EAttribute | aEclass.eAllAttributes)]
                ps.set[aEAttribute.eType.instanceClassName.toUpperFirst()/]([i/],
mb.get[aEAttribute.name.toUpperFirst()/]());

    [/for]
    [for (aEReference : EReference | aEclass.eAllReferences)]
                ps.set[aEReference.eType.instanceClassName.toUpperFirst()/]([i/],
mb.get[aEReference.name.toUpperFirst()/]());

    [/for]

    ps.executeUpdate();
    con.commit();

        ps.close();
        con.close();

        }
        catch(Exception e){
            e.printStackTrace();
        }


            return SUCCESS;

    }

}
[/file]
```

Figure 8. Template of Create Action Class.

b) Template of Retrieve Action Class

This template permits to generate a retrieve class Action. This latter allows display all employees, departments and cities existing in the BD. The figure 9 shown below presents this template.

```
[file ('Retrieve'.concat(aEclass.name).concat('Action').concat('.java'), false,
'UTF-8')]
    [comment]//RetrieveAction Class[/comment]
    package GenerateStruts2;
    import java.sql.DriverManager;
    import java.sql.ResultSet;
    import java.sql.Statement;
    import java.util.ArrayList;
    import java.util.List;
    import javax.servlet.http.HttpServletRequest;
    import org.apache.struts2.interceptor.ServletRequestAware;
    import com.opensymphony.xwork2.ActionSupport;

    public class Retrieve[aEclass.name.toUpperFirst()/]Action extends ActionSupport
 implements ServletRequestAware{
        private static final long serialVersionUID = 1L;
        HttpServletRequest request;

    public String execute()
    {
    try{
    Class.forName("oracle.jdbc.driver.OracleDriver");
    java.sql.Connection con
=DriverManager.getConnection("jdbc:oracle:thin:@localhost:1521:XE","system","admin");
    Statement st=con.createStatement();
    ResultSet rs = st.executeQuery("select * from [aEclass.name/]");

        List<[aEclass.name.toUpperFirst()/]Bean> li = null;
        li = new ArrayList<[aEclass.name.toUpperFirst()/]Bean>();
        [aEclass.name.toUpperFirst()/]Bean mb = null;

        while(rs.next())
            {
                mb = new [aEclass.name.toUpperFirst()/]Bean();
                [for (aEAttribute : EAttribute | aEclass.eAllAttributes)]

    mb.set[aEAttribute.name.toUpperFirst()/](rs.get[aEAttribute.eType.instanceClassName
toUpperFirst()/]("[aEAttribute.name/]"));
                [/for]
                [for (aEReference : EReference | aEclass.eAllReferences)]
                mb.set[aEReference.name.toUpperFirst()/](rs.get[aEReference.eType.insta
nceClassName.toUpperFirst()/]("[aEReference.name/]"));
                [/for]
            li.add(mb);
            }

        request.setAttribute("disp", li);
        rs.close();
        st.close();
        con.close();
                }
        catch(Exception e){
            e.printStackTrace();
        }
        return SUCCESS;
    }
    public void setServletRequest(HttpServletRequest request) {
        this.request = request;
    }
    public HttpServletRequest getServletRequest() {
        return request;
    }
    }
[/file]
```

Figure 9. Template of Retrieve Action Class.

c) Template of Update Action Class.

This template allows generate an Update class Action. This latter allows modify an existing employee, an existing department or an existing city. The figure 10 shown below presents this template.

```
[file ('Update'.concat(aEclass.name).concat('Action').concat('.java'), false, 'UTF-8')]
[comment]//Update Action Class[/comment]
package GenerateStruts2;
import java.sql.DriverManager;
import java.sql.PreparedStatement;
import java.sql.ResultSet;
import com.opensymphony.xwork2.ActionSupport;

public class Update[aEclass.name.toUpperFirst()/]Action extends ActionSupport{
    private static final long serialVersionUID = 1L;

    [aEclass.name/] mb=new [aEclass.name/]();

    public [aEclass.name/] getMb() {
        return mb;
    }
    public void setMb([aEclass.name/] mb) {
        this.mb = mb;
    }

    public String execute()
    {

    try{
    Class.forName("oracle.jdbc.driver.OracleDriver");
    java.sql.Connection con
=DriverManager.getConnection("jdbc:oracle:thin:@localhost:1521:XE","system","admin");

    String s = "update [aEclass.name/] set [for (aEAttribute : EAttribute |
aEclass.eAllAttributes)]
        [if (i<>1)] [aEAttribute.name/]=?, [/if][/for]
            [for (aEReference : EReference |
aEclass.eAllReferences)][aEReference.name/]=?,[/for] where id=?";

    PreparedStatement ps=con.prepareStatement(s);
    [for (aEAttribute : EAttribute | aEclass.eAllAttributes)]
        [if (i<>1)] ps.set[aEAttribute.eType.instanceClassName.toUpperFirst()/]([i-1/],
mb.get[aEAttribute.name.toUpperFirst()/]());[/if][/for]

    [for (aEAttribute : EAttribute | aEclass.eAllAttributes)]
        [if (i=1)]
ps.set[aEAttribute.eType.instanceClassName.toUpperFirst()/]([aEclass.eAllAttributes->s
ize()/], mb.get[aEAttribute.name.toUpperFirst()/]());[/if][/for]

    [for (aEReference : EReference | aEclass.eAllReferences)]
        [if (i<>1)]ps.set[aEReference.eReferenceType.name.toUpperFirst()/]([i-1/],
mb.get[aEReference.name.toUpperFirst()/]());[/if][/for]

    [for (aEReference : EReference | aEclass.eAllReferences)]
        [if
(i=1)]ps.set[aEReference.eReferenceType.name.toUpperFirst()/]([aEclass.eAllReferences-
size()/], mb.get[aEReference.name.toUpperFirst()/]());[/if][/for]

    ps.executeUpdate();
    con.commit();
    ps.close();
    con.close();
            }
        catch(Exception e){
            e.printStackTrace();
        }
            return SUCCESS;
    }
 }
[/file]
```

Figure 10. Template of Update Action Class.

d) Template of Delete Action Class.

This template permits to generate a Delete class Action. This latter allows delete a selected employee from the existing list of employees, departments or cities in database. The figure 11 shown below presents this template.

```
    [file ('Delete'.concat(aEclass.name).concat('Action').concat('.java'), false,
'UTF-8')]
    [comment]//DeleteAction Class[/comment]
    package GenerateStruts2;
    import java.sql.DriverManager;
    import java.sql.PreparedStatement;
    import javax.servlet.http.HttpServletRequest;
    import org.apache.struts2.interceptor.ServletRequestAware;
    import com.opensymphony.xwork2.ActionSupport;

    public class Delete[aEclass.name.toUpperFirst()/]Action extends ActionSupport
implements ServletRequestAware{
    private static final long serialVersionUID = 1L;

    HttpServletRequest request;

    public String execute()
    {

    try{
    Class.forName("oracle.jdbc.driver.OracleDriver");
    java.sql.Connection con
=DriverManager.getConnection("jdbc:oracle:thin:@localhost:1521:XE","system","admin");
    PreparedStatement ps=null;

    String cv [ '[' /][ ']' /]  =request.getParameterValues("rdel");

    for(int i=0;i<cv.length;i++)
    {
        ps=con.prepareStatement("delete from [aEclass.name/] where SNO=(?)");
        int k = Integer.parseInt(cv[ '[' /]i[ ']' /]);
        System.out.println("this is" +k);
        ps.setInt(1,k);
        ps.executeUpdate();
        con.commit();
    }

        ps.close();
        con.close();

            }
        catch(Exception e){
            e.printStackTrace();
        }
            return SUCCESS;
    }

    public void setServletRequest(HttpServletRequest request) {
        this.request = request;
    }

    public HttpServletRequest getServletRequest() {
        return request;
    }

}

    [/file]
```

Figure 11. Template of Delete Action Class.

2) Template of JSP pages

According to the figure 8, the different templates which constitute the super template "Template View" are as follow: "Template of Create Jsp Page", "Template of Retrieve Jsp page", "Template of Update Jsp page" and "Template of Delete Jsp page".

a) Template of Create Jsp page

This template permits to generate a "*Create JSP page*". This page allows insert or create a new employee, a new city or a new department in the database. It represents the layer presentation of the application. The figure 12 shown below presents this template.

```
[comment @main /]
[file ('Create'.concat(aEclass.name).concat('.jsp'), false, 'UTF-8')]
 package generateJsp;
<%@ page language="java" contentType="text/html; charset=UTF-8" pageEncoding="UTF-8"%>
<%@ taglib prefix ="s" uri="/struts-tags"%>
<!DOCTYPE html PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
 "http://www.w3.org/TR/html4/loose.dtd">
<html>
<head>
<meta http-equiv="Content-Type" content="text/html; charset=UTF-8">
<title> Create [aEclass.name.toUpperFirst()/]</title>
</head>
<body>
<center><h2>Welcome to Create [aEclass.name.toUpperFirst()/]</h2>

    <div id="formulaire">
        <s:form method ="post" action="Save_[aEclass.name.toUpperFirst()/]">
        [for (aEAttribute : EAttribute | aEclass.eAllAttributes)]

            <s:textfield name="[aEAttribute.name/]" id="[aEAttribute.name/]"
                label="[aEAttribute.name.toUpperFirst()/]" labelposition="left">
            </s:textfield>
        [/for]
        [for (aEReference : EReference | aEclass.eAllReferences)]
            <s:textfield name="[aEReference.name/]" id="[aEReference.name/]"
                label="[aEReference.name.toUpperFirst()/]" labelposition="left">
            </s:textfield>
        [/for]

            <s:submit value = "Envoyer"></s:submit>

        </s:form>
    </div>
</center>
</body>
</html>
[/file]
```

Figure 12. Template of Create JSP page.

b) *Template of Retrieve Jsp page*

This template permits to generate a Retrieve JSP page. This page allows display all employees, all departments or cities existing in database. The figure 13 shown below presents this template.

```
[comment @main /]
[file ('Retrieve'.concat(aEclass.name).concat('.jsp'), false, 'UTF-8')]
 package generateJsp;
<%@ page language="java" contentType="text/html; charset=UTF-8" pageEncoding="UTF-8"%
<%@ taglib prefix="s" uri="/struts-tags"  %>
<!DOCTYPE html PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
 "http://www.w3.org/TR/html4/loose.dtd">
<html>
<head>
<meta http-equiv="Content-Type" content="text/html; charset=UTF-8">
<title>Retrieve [aEclass.name.toUpperFirst()/]</title>
</head>
<body>
<center><div>
    <center><h2>[aEclass.name.toUpperFirst()/] List </h2></center>

      <s:if test="%{[aEclass.name.toUpperFirst()/].size()>0}">
            <s:iterator value="list[aEclass.name.toUpperFirst()/]"><br/>

                [for (aEAttribute : EAttribute | aEclass.eAllAttributes)]
                [aEAttribute.name.toUpperFirst()/] : <s:property
 value="[aEAttribute.name/]"/><br/>
                [/for]

                [for (aEReference : EReference | aEclass.eAllReferences)]
                [aEReference.name.toUpperFirst()/] : <s:property
 value="[aEReference.name/]"/><br/>
                [/for]
        </s:if>
        <s:else>
                No items in the list
        </s:else>

    </div>
   </center>
</body>
</html>
[/file]
```

Figure 13. Template of Retrieve JSP page.

c) *Template of Update Jsp page*

This template permits to generate an Update JSP page. This page allows modify or update an employee, information of a department or city existing in database. The figure 14 shown below presents this template.

```
[comment @main /]
[file ('Update'.concat(aEclass.name).concat('.jsp'), false, 'UTF-8')]
 package generateJsp;
<%@ taglib prefix="s" uri="/struts-tags" %>
<%@ page import="java.util.*;" %>

<html>

<head>
<link rel="stylesheet" type="text/css" href="css/java4s.css" />
</head>

<body>
<a href="<s:url action="view.action"/>">Display [aEclass.name/]</a>
<br><br>

<b><font color="#5d8122" face="verdana">Update [aEclass.name/]</font></b>

    <s:form action="updates">

        [for (aEAttribute : EAttribute | aEclass.eAllAttributes)]

            <s:textfield label="[aEAttribute.name.toUpperFirst()/]"
 value="%{#application.a[i/]"}" name="mb.[aEAttribute.name/]"
                [if (i=1)] readonly="true" [/if] cssClass="bord">
            </s:textfield>
        [/for]

        [for (aEReference : EReference | aEclass.eAllReferences)]

            <s:textfield label="[aEReference.name.toUpperFirst()/]"
 value="%{#application.a[i/]"}" name="mb.[aEReference.name/]"
                [if (i=1)] readonly="true" [/if] cssClass="bord">
            </s:textfield>
        [/for]

    <s:submit value="Update"/>

</s:form>

</body>
</html>
[/file]
```

Figure 14. Template of Update JSP page.

d) *Template of Delete Jsp page*

This template permits to generate Delete JSP page. This page allows delete or destruct an employee, a department or city existing in database. The figure 15 shown below presents this template.

```
[comment @main /]
[file ('Delete'.concat(aEclass.name).concat('.jsp'), false, 'UTF-8')]
 package generateJsp;
<%@ taglib prefix="s" uri="/struts-tags" %>
<%@ page import="java.util.*;" %>

<head>
<link rel="stylesheet" type="text/css" href="css/java4s.css" />
<script type="text/javascript">
function deleteRecord()
    {
        document.fom.action="del.action";
        document.fom.submit();
    }
function editr(val)
{
    document.fom.action="update.action?fid="+val;
    document.fom.submit();
}
</script>
</head>

<a href="<s:url action="savelink.action"/>">Insert</a>
<br><br>

<table class="bordt">
<form name="fom" method="post">
<%
List l=(List)request.getAttribute("disp");
if(l!=null)
{
    Iterator it=l.iterator();

    while(it.hasNext())
    {
        GenerateStruts2.[aEclass.name/] b=(GenerateStruts2.[aEclass.name/])it.next();
        [for (aEAttribute : EAttribute | aEclass.eAllAttributes)]
        [aEAttribute.eType.instanceClassName/]
 temp[aEAttribute.name.toUpperFirst()/]=b.get[aEAttribute.name.toUpperFirst()/]();
        [/for]
        [for (aEReference : EReference | aEclass.eAllReferences)]
        [aEReference.eType.instanceClassName/]
 temp[aEReference.name.toUpperFirst()/]=b.get[aEReference.name.toUpperFirst()/]();
        [/for]
    %>
        <tr>
        <td class="bord"><input type="checkbox" value="<%= tempId %>" name="rdel"></td>
        [for (aEAttribute : EAttribute | aEclass.eAllAttributes)]
        <td class="bord"><%= temp[aEAttribute.name.toUpperFirst()/] %></td>
        [/for]

        [for (aEReference : EReference | aEclass.eAllReferences)]
        <td class="bord"><%= temp[aEReference.name.toUpperFirst()/] %></td>
        [/for]
        <td class="bord"><a href="javascript:editr('<%= tempId %>')">Edit</a></td>
        </tr>
    <%
    }
}
%>
<input type="button" value="delete" onclick="deleteRecord();">
</table>
</form>
[/file]
```

Figure 15. Template of Update JSP page.

VII. MODEL-TO-TEXT TRANSFORMATION RESULT

According to the generated PSM model (Figure 5), the different classes and JSP pages generated in this paper are listed in the figure 16 for the Action classes and in the figure 21 for the JSP pages.

In the next section, we present the different Action classes that are the CRUD Action classes.

A. *Action classes Result*

The Action class is one of Struts 2 novelties, the developer is no longer constrained to extend a given class and frees up J2EE objects to facilitate unit tests. It leaves the possibility of creating a mother class for its controllers, in which you can write all their common code (factorization) and which will implement the "*ActionSupport*" interface. The different Action classes generated in this paper are shown in the following figure.

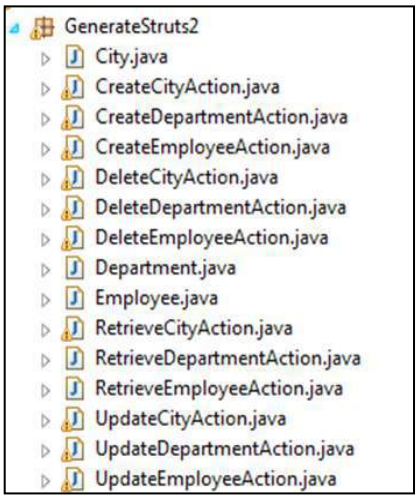

Figure 16. The different generated classes.

In the next section, we present the different classes listed in the above figure (Figure 16).

For letting this paper quite understandable and clear, we present only one example of each Action class. We note that in the application we arrived to generate all classes and all JSP pages.

1) *Create Action Class*

This class is the result of M2T transformation by using the ACCELEO generation language. The Create Action Class "*CreateActionClass*" allows insert or create a new employee, a new city or a new department. In this case, we present the "*CreateEmployeeAction.java" class*. Figure 17 shows this class.

```
CreateEmployeeAction.java

package GenerateStruts2;

import java.sql.DriverManager;

public class CreateEmployeeAction extends ActionSupport{
    private static final long serialVersionUID = 1L;

    Employee mb=new Employee();

    public Employee getMb() {
        return mb;
    }
    public void setMb(Employee mb) {
        this.mb = mb;
    }


    public String execute()
    {

    try{
    Class.forName("oracle.jdbc.driver.OracleDriver");
    java.sql.Connection con
 =DriverManager.getConnection("jdbc:oracle:thin:@localhost:1521:XE","system","admin");

    String s = "insert into Employee values(?,?,?)";
    PreparedStatement ps=con.prepareStatement(s);
                ps.setInt(1, mb.getId());

                ps.setString(2, mb.getName());


    ps.executeUpdate();
    con.commit();

        ps.close();
        con.close();

            }
        catch(Exception e){
            e.printStackTrace();
        }


            return SUCCESS;

    }

}
```

Figure 17. Create Class Action:"CreateEmployeeAction.java".

2) *Retrieve Action class*

This class is the result of M2T transformation by using the ACCELEO generation language. The Retrieve Action Class "*RetrieveActionClass.java*" allows retrieve or lists all employees, all cities or all departments. In this case, we present the "*RetrieveDepartmentAction.java" class.* Figure 18 presents this class.

```
RetrieveDepartmentAction.java

package GenerateStruts2;
import java.sql.DriverManager;
import java.sql.ResultSet;
import java.sql.Statement;
import java.util.ArrayList;
import java.util.List;
import javax.servlet.http.HttpServletRequest;
import org.apache.struts2.interceptor.ServletRequestAware;
import com.opensymphony.xwork2.ActionSupport;

public class RetrieveDepartmentAction extends ActionSupport{
    private static final long serialVersionUID = 1L;
    HttpServletRequest request;

public String execute()
{
try{
Class.forName("oracle.jdbc.driver.OracleDriver");
java.sql.Connection con
 =DriverManager.getConnection("jdbc:oracle:thin:@localhost:1521:XE","system","admin");
Statement st=con.createStatement();
ResultSet rs = st.executeQuery("select * from Department");

    List<Department> l1 = null;
    l1 = new ArrayList<Department>();
    Department mb = null;

    while(rs.next())
        {
            mb = new Department();
            mb.setId(rs.getInt("id"));
            mb.setName(rs.getString("name"));
            //mb.setEmployee(rs.getEmployee("employee"));
        l1.add(mb);
        }

    //request.setAttribute("disp", l1);
    rs.close();
    st.close();
    con.close();
        }
    catch(Exception e){
        e.printStackTrace();
    }
    return SUCCESS;
}

}
```

Figure 18. Retrieve Class Action:"RetrieveDepartmentAction.java".

3) *Update class*

This class is the result of a M2T transformation by using e ACCELEO generation language. The Update Action Class allows modify or update an employee, a city or a department. In this case, we present the "*UpdateDepartmentAction"* that permits to update the information of a given Department. The figure 19 shown below presents this class.

```
UpdateDepartmentAction.java

package GenerateStruts2;

import java.sql.DriverManager;
import java.sql.PreparedStatement;
import java.sql.ResultSet;
import com.opensymphony.xwork2.ActionSupport;

public class UpdateDepartmentAction extends ActionSupport{
    private static final long serialVersionUID = 1L;

    Department mb=new Department();

    public Department getMb() {
        return mb;
    }
    public void setMb(Department mb) {
        this.mb = mb;
    }

    public String execute()
    {

    try{
    Class.forName("oracle.jdbc.driver.OracleDriver");
    java.sql.Connection con
 =DriverManager.getConnection("jdbc:oracle:thin:@localhost:1521:XE","system","admin");

    String s = "update Department set  name=?, employee=?, where id=?";

    PreparedStatement ps=con.prepareStatement(s);
    ps.setString(1, mb.getName());
    ps.setInt(2, mb.getId());
    //ps.setEmployee(1, mb.getEmployee());
    ps.executeUpdate();
    con.commit();
    ps.close();
    con.close();
            }
        catch(Exception e){
            e.printStackTrace();
        }
            return SUCCESS;
    }
}
```

Figure 19. Update class Action: "UpdateDepartmentAction.jsp".

4) *Delete class Action*

This class is the result of M2T transformation by using the ACCELEO generation language. The Delete Action Class "*DeleteActionClass*" allows delete an employee, a city or a department from database. In this case, we present the "*DeleteDepartmentAction.java"*. Figure 20 shows this class.

```
DeleteDepartmentAction.java

package GenerateStruts2;
import java.sql.DriverManager;
import java.sql.PreparedStatement;
import javax.servlet.http.HttpServletRequest;
import org.apache.struts2.interceptor.ServletRequestAware;
import com.opensymphony.xwork2.ActionSupport;

public class DeleteDepartmentAction extends ActionSupport {
private static final long serialVersionUID = 1L;

HttpServletRequest request;

public String execute()
{

try{
Class.forName("oracle.jdbc.driver.OracleDriver");
java.sql.Connection con
=DriverManager.getConnection("jdbc:oracle:thin:@localhost:1521:XE","system","admin");
PreparedStatement ps=null;

String cv []=null;//  =request.getParameterValues("rdel");

for(int i=0;i<cv.length;i++)
{
    ps=con.prepareStatement("delete from Department where SNO=(?)");
    int k = Integer.parseInt(cv[i]);
    System.out.println("this is" +k);
    ps.setInt(1,k);
    ps.executeUpdate();
    con.commit();
}

    ps.close();
    con.close();

        }
    catch(Exception e){
        e.printStackTrace();
    }
        return SUCCESS;
}

}
```

Figure 20. Delete class Action: "DeleteDepartmentAction.jsp".

B. Generated JSP pages

The different JSP pages generated by ACCELEO generator is shown in figure 21.

For letting this paper quite understandable and clear, we present only one example of each JSP page. We note that we have been able to generate all the requested JSP pages according to the generated Struts2 model presented in figure 5.

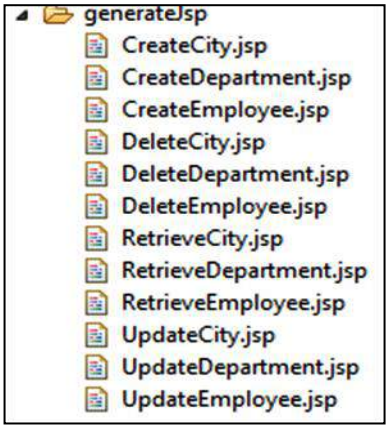

Figure 21. The generated Jsp page

5) Create Jsp page

This jsp page is the M2T transformation result by ACCELEO generation language. The Create jsp page "*CreateClass*" allows insert or create a new employee, a new city or a new department in database. In this case, we present the "*CreateCity.jsp" jsp page*. Figure 22 presents this jsp page.

```
CreateCity.jsp

package generateJsp;
<%@ page language="java" contentType="text/html; charset=UTF-8" pageEncoding="UTF-8"%>
<%@ taglib prefix -"s" uri-"/struts-tags"%>
<!DOCTYPE html PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
 "http://www.w3.org/TR/html4/loose.dtd">
<html>
<head>
<meta http-equiv="Content-Type" content="text/html; charset=UTF-8">
<title> Create City</title>
</head>
<body>
<center><h2>Welcome to Create City</h2>

    <div id-"formulaire">
        <s:form method ="post" action="Save_City">

            <s:textfield name="id" id="id" label="Id" labelposition="left">
            </s:textfield>

            <s:textfield name="name" id="name" label="Name" labelposition="left">
            </s:textfield>
            <s:textfield name="department" id="department" label="Department"
 labelposition="left">
            </s:textfield>

            <s:submit value = "Envoyer"></s:submit>

        </s:form>
    </div>
</center>
</body>
</html>
```

Figure 22. Create JSP page:"CreateCity.jsp".

6) Retrieve Jsp Page

This JSP page is the M2T transformation result by using ACCELEO generation language. The Retrieve JSP page "*RetrieveClass.jsp*" allows retrieve or lists all employees, all cities or all departments. In this case, we present the "*RetrieveEmployee.jsp" class*. Figure 23 shows this class.

```
RetrieveEmployee.jsp

package generateJsp;
<%@ page language="java" contentType="text/html; charset-UTF-8" pageEncoding-"UTF-8"%>
<%@ taglib prefix="s" uri="/struts-tags"  %>
<!DOCTYPE html PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
 "http://www.w3.org/TR/html4/loose.dtd">
<html>
<head>
<meta http-equiv-"Content-Type" content="text/html; charset-UTF-8">
<title>Retrieve Employee</title>
</head>
<body>
<center><div>
    <center><h2>Employee List </h2></center>

      <s:if test="#{Employee.size()>0}">
            <s:iterator value="listEmployee"><br/>

                Id : <s:property value="id"/><br/>
                Name : <s:property value="name"/><br/>
                LastName : <s:property value="lastName"/><br/>

                </s:if>
                <s:else>
                    No items in the list
                </s:else>


    </div>
   </center>

</body>
</html>
```

Figure 23. Retrieve JSP page:"RetrieveEmployee.jsp".

7) Update Jsp page

This jsp page is the M2T transformation result by using ACCELEO generation language. The Update jsp page allows modify or update an employee, a city or a department. In this case, we present the "*UpdateCity.jsp"* that permits to update the information of a given Department in database. Figure 24 shows this jsp page.

```
UpdateCity.jsp

package generateJsp;
<%@ taglib prefix="s" uri="/struts-tags" %>
<%@ page import="java.util.*;" %>

<html>

<head>
<link rel="stylesheet" type="text/css" href="css/java4s.css" />
</head>

<body>
<a href="<s:url action="View.action"/>">Display City</a>
<br><br>

<b><font color="#5d8122" face="verdana">Update City</font></b>

    <s:form action="updates">

            <s:textfield label="Id" value="%{#application.a1}" name="mb.id"
 readonly="true"  cssClass="bord">
            </s:textfield>

            <s:textfield label="Name" value="%{#application.a2}" name="mb.name"
 cssClass="bord">
            </s:textfield>

            <s:textfield label="Department" value="%{#application.a1}"
name="mb.department" readonly="true"  cssClass="bord">
            </s:textfield>
    <s:submit value="Update"/>

</s:form>

</body>
</html>
```

Figure 24. Update JSP page:"UpdateCity.jsp".

8) Delete Jsp page

This page is the result of M2T transformation by using ACCELEO generation language. The Delete jsp page "*DeleteClass*" allows delete an employee, a city or a department from database. In this case, we present the "DeleteDepartment.jsp*"*. Figure 25 shows this jsp page.

```
DeleteDepartment.jsp

package generateJsp;
<%@ taglib prefix="s" uri="/struts-tags" %>
<%@ page import="java.util.*;" %>

<head>
<link rel="stylesheet" type="text/css" href="css/java4s.css" />
<script type="text/javascript">
function deleteRecord()
    {
        document.fom.action="del.action";
        document.fom.submit();
    }
function editr(val)
{
    document.fom.action="update.action?Eid="+val;
    document.fom.submit()
}
</script>
</head>

<a href="<s:url action="saveLink.action"/>">Insert</a>

<br><br>

<table class="bordt">
<form name="fom" method="post">
<%
List l=(List)request.getAttribute("disp");
if(l!=null)
{

    Iterator it=l.iterator();

    while(it.hasNext())
    {

        GenerateStruts2.Department b=(GenerateStruts2.Department)it.next();
        int tempId=b.getId();
        String tempName=b.getName();

         Employee tempEmployee=b.getEmployee();

    %>

        <tr>
        <td class="bord"><input type="checkbox" value="<%= tempId %>" name="rdel"></td>
        <td class="bord">&lt;%= tempId %&gt;</td>
        <td class="bord">&lt;%= tempName %&gt;</td>

        <td class="bord">&lt;%= tempEmployee %&gt;</td>
        <td class="bord"><a href="javascript:editr('<%= tempId %>')">Edit</a></td>
        </tr>

    <%

    }

}

%>
<input type="button" value="delete" onclick="deleteRecord();">
</table>

</form>
```

Figure 25. Delete JSP page:"DeleteDepartment.jsp".

VIII. EVALUATION

In this paper, we was conducted a process of code generation by using Acceleo generator. After generating this code, we want to know the percentage of the generated code with respect to the total application code. In this case study, we obtained a very respectful percentage of code generation occurred. The generated code has reached into 100% of total code.

IX. RELATED WORK

After examining the related work concerning the automatic code generation by applying MDA approach, we can cite several works that are conducted in this domain such as: [26]-[11]-[27]-[28]-[29]-[30]-[31]-[32]-[33]-[34]-[36].

The work presented in [26] permits to generate only JSP pages and JavaBeans by applying the UWE [11] and ATL as a transformation language [24].

The work cited in [27] permits to transform the PIMs models implemented by Enterprise Distributed Object into PSMs for different services platforms. The transformation rules of this work are defined by ATL language. This work generates only the PSM model.

In [28], Billing et al., explains the different transformation rules permits to transform PIM into PSM in the EJB context. The different transformation rules of this work are defined by the approach by modeling based on QVT.

The work presented in [29] considers that MDA is a software industrialization pattern (or a software factory). The idea of this work is illustrated by a real case study in an IT services company. The main objective is to create MDA tools founded on XMI, XSLT and Visitor pattern. .It is a proposal to create MDA tools taking as base XMI, XSLT and the Visitor pattern.

In [30], the objective of this work is the model-driven development approach for E-Learning platform. Thereby, the authors implement the CIM model by analyzing business logic. And thereafter, they establish the system diagram and the robustness analysis. Thus, the authors define a transformation method from PIM to PSM layer by layer.

In the work [31] the objective is to integrate a new framework for secure Data Warehouses design by applying the approach by modeling based on QVT.

In [32], the author presents the AndroMDA approach of the community of web-based MDA [32]. This work permits to transform a PIM schemes to model by integrating a wide variety of scenarios and comes with a set of plug-ins, called cartridge.

In [33], the authors arrived to generate a MVC 2 web model from Struts framework. The meta-model of Struts is realized in first time in this work. The different transformation rules of this work are defined by ATL language in view to generate the CRUD operations from three classes Ci, Cj and Ck.

The subject of the work [34] is to generate the MVC 2 web model from the combination of UML class diagram and the UML activity diagram. The work presented in [35] is the continuation of [34], the objective of this work is to generate the code from the MVC2 web model already generated in [34] by using the JET2 generator.

In [38], the authors arrived to generate the MVC2 web model, but in this case, from the combination of UML class diagram and UML sequence diagram. This work is considering as an end-to-end code generation by using JET2 generator and based in the MDA approach.

The objective of the work presented in [36] is to generate the N-tiers PSM model by integrating Struts2, Spring IoC and Hibernate DAO frameworks. The different transformation rules of this work are defined by ATL language.

The objective of the paper [37] is to generate the Struts2 PSM model and to validate the ATL transformation rules presented in this work which was not possible in [33]-[34]-[35]-[36]-[38]. This paper describes a new validation method of ATL transformation rules and the test of this method by a case study.

Thus, we can say that the main contributions of our approach compared to others are: the use of ACCELEO generator to generate the code of Struts2 framework which was not possible in the case of [34]-[35]-[38]. This work is realized for the first time in this paper.

X. Conclusion and Future Work

Model-driven architecture (MDA) is a software development approach proposed and supported by the OMG foundation. This is a particular variant of model-driven engineering (MDE). A typical example of MDA approach is the automatic generation of source code from UML modeling, which involves combining: The UML standard, the modeling tool that implements it and the UML generation templates. The passage from the PSM to the code generation is the logical continuation of this treatment. It can be realized by generators such as these in order to produce any type of technological targets.

In this paper, we generate a MVC2 web code from Struts2 model already generated by applying an ATL transformation. This is the M2M transformation. After that, we implement the model-to-text transformation based on the MDA approach in view to obtain the code of this application from the generated model. Thereby, this transformation is started by the M2M transformation to obtain the PSM Struts2 model. The generated PSM model is an EMF model. This latter is used, in the M2T transformation, as an input model of Acceleo generator to produce automatically the necessary target application code. Finally, the code generation result was demonstrated and exemplified by a case study.

Furthermore, we plan to generate an e-commerce web code from a PSM model result of the integration of struts2, Spring IoC and Hibernate DAO. In other hand, we can extend this method for considering other frameworks like: PHP, Zend and DotNet.

References

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A Review on Image Enhancement Techniques

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***Abstract*— Image enhancement is one of the challenging issues in image processing. The objective of Image enhancement is to process an image so that result is more suitable than original image for specific application. Digital image enhancement techniques provide a lot of choices for improving the visual quality of images. Appropriate choice of such techniques is very important. This paper will provide an overview and analysis of different techniques commonly used for image enhancement. Image enhancement plays a fundamental role in vision applications. Recently much work is completed in the field of images enhancement. Many techniques have previously been proposed up to now for enhancing the digital images. In this paper, a survey on various image enhancement techniques has been done.**

Keywords-component; Digital Image Processing, Histogram Equalization, Image Enhancement.

I. INTRODUCTION

Various kinds of image and pictures are used as the source of information in present day applications and communication system. whenever an image is taken some of the degradation may occur like blurred image. Also, when an image is converted from one form to another form such as scanning, transmitting, storing etc., some of the degradation occurs at the output. Hence the output image must need to improve for the batter visual appearance of an image. Image denoising, enhancement and sharpening are important operations in the general fields of image processing and computer vision. Enhancement of noisy image is a very challenging task in many research and application area. There is a collection of techniques to improve the visual appearance of an image, like image enhancement, image deblurring, image sharpening, image smoothing, image filtering and various noise removing techniques.

Image enhancement process consist to improve the appearance of an image or to convert the image to a form better suited for analysis by a human or a machine. Enhancement of image is very challenging issue in many research and application areas. Image enhancement techniques are used to improve certain features by modifying the colors or intensities. Technique applied for enhancing is applicable for medical image processing and image processing application areas like satellite image processing, biometric image processing etc.

II. IMAGE ENHANCEMENT TECHNIQUES

Various techniques are used for image enhancement, which are given below.

A. Histogram equalization

Histogram equalization is a very common technique for enhancing the images. Suppose we have an image which is predominantly dark. Then its histogram would be skewed towards the lower end of the grey scale and all the image detail is compressed into the dark end of the histogram. If it could `stretch out' the grey levels at the dark end to produce a more uniformly distributed histogram then the image would become much clearer. Histogram equalization stretches the histogram across the entire spectrum of pixels (0 – 255). It increases the contrast of images for the finality of human inspection and can be applied to normalize illumination variations in image understanding problems. Histogram equalization is one of the operations that can be applied to obtain new images based on histogram specification or modification. Histogram equalization is considered a global technique. This process is quite simple and for each brightness level j in the original image, the new pixel level value (k) is calculated as given in equation 3.1.

$$K = \sum_{i=0}^{j} \frac{N_i}{T} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

Where the sum counts the number of pixels in the image with brightness equal to or less than j, and T is the total number of pixels. The main purpose of histogram equalization is to find gray level transformation function T to transform image f such that the histogram of T(f) is equalized.

B. Adaptive histogram equalization

Histogram equalization expand active range of strength value while squash the histogram. On many images, histogram equalization provides suitable results, but suitable to its global

treatment of the image, sometimes it more than enhance the image. It's used to enhance difference in images. Histogram equalization highlight only on local compare place of overall compare. Adaptive histogram equalization overcomes from this topic, this technique appropriate for general techniques. Once the image contain region that are expansively lighter and dark, the contrast in those regions will not be sufficiently enhanced. So adaptive histogram equalization compute correctly image region. Adaptive histogram equalization enhances the contrast of images by transform the values in the intensity image. The contrast transform meaning is calculating for each of these regions independently. The optimal size of region depends on the type of the input image, and it is superlative determined during experimentation.

C. Fuzzy Logic Technique

Fuzzy-logic has been efficiently found in different elements of image processing. Recently fuzzy based algorithms for image enhancement have been developed with better performance com-pared to conventional and other advanced techniques like GLG. Fuzzy image processing includes mainly three stages: image fuzzification, modification of membership values, and, if necessary, image DE fuzzification. After the image data are transformed from gray-level domain to the fuzzy membership domain (fuzzification), appropriate fuzzy techniques modify the membership values.

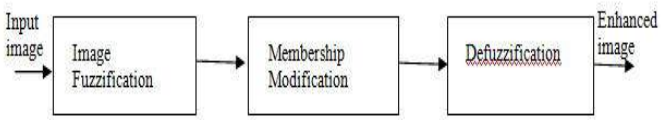

Figure 1. The main principle of Fuzzy Image enhancement

D. Nuro Fuzzy System

Neuro-fuzzy systems are the Artificial Neural Network (ANN) based fuzzy systems. ANN determines the properties of data samples by processing it. Predictive power of ANN is more than that of signal analysis techniques. Fuzzy set theory is essential, for dealing with uncertainty. Neuro-Fuzzy system is a system where the fuzzy rules and sets are adjusted using neural network techniques in iterative manner with the set of pair of input and output data vectors. First such system behaves like a neural network where learning of parameters occurs and at the time of execution it behaves like a fuzzy.

Neural network will detect types of noise whether it is salt and pepper, gaussian and non-gaussian noise. And then Fuzzy logic will apply proper filter based on type of noise.

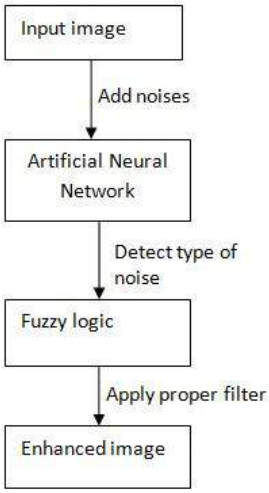

Figure 2. The principle of Nuro-Fuzzy Image enhancement

E. Unsharp Masking

In the un-sharp masking (UM) approach for image enhancement, a fraction of the high-pass filtered image is added to the original one to form the enhanced image. In this method, un-sharp masking is applied in partial way for detection of the edges and boundary lines in the image and then a conservative smoothing operation is applied on the selected areas to remove undesirable edges which represents the salt and pepper noise. Finally, the noise free edge image is added with the smoothed image to get the original image with reduced noise. The input/output relation for the un-sharp masking filter can be written as follows:

$$x' = x + \lambda z \quad \ldots\ldots\ldots\ldots\ldots\ldots$$

Where are the inputs, output images and is a positive constant which controls the fraction of the high-pass filtered image z to be added to the input image.

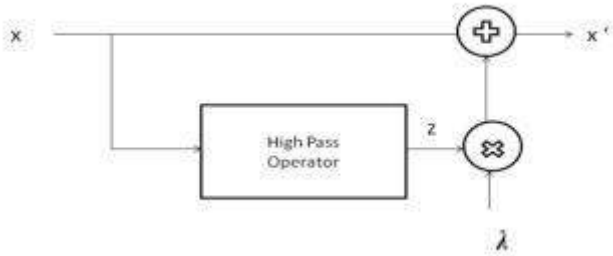

Figure 3. The un-sharp masking structure

F. Contrast Stretching

To expand the range of brightness values in an image the contrast enhancement techniques are used, so that the image can be efficiently displayed in a manner desired by the analyst. The level of contrast in an image may vary due to poor illumination or improper setting in the acquisition sensor device. Therefore, there is a need to manipulate the contrast of

an image to compensate for difficulties in image acquisition. The idea behind contrast stretching is to increase the dynamic range of the gray levels in the image being processed. The idea is to modify the dynamic range of the grey-levels in the images. Linear Contrast Stretch is the simplest contrast stretch algorithm that stretches the pixel values of a low-contrast image or high contrast image by extending the dynamic range across the whole image spectrum from 0 – (L-1).

G. Thresholding Transformations

Thresholding transformations are particularly useful for segmentation in which we want to isolate an object of interest from a background. Image threshold is the process of separating the information (objects) of an image from its background, hence, thresholding is usually applied to grey-level or color document scanned images. Thresholding can be categorized into two main categories: global and local. Global thresholding methods choose one threshold value for the entire document image, which is often based on the estimation of the background level from the intensity histogram of the image; hence, it is considered a point processing operation. Global thresholding methods are used to automatically reduce a grey-level image to a binary image. The images applied to such methods are assumed to have two classes of pixels (foreground and background). The purpose of a global thresholding method is to automatically specify a threshold value T, where the pixel values below it is considered foreground and the values above are background. A simple method would be to choose the mean or median value of all the pixels in the input image, the mean or median will work well as the threshold, however, this will generally not be the case especially if the pixels are not uniformly distributed in an image.

Local adaptive thresholding uses different values for each pixel according to the local area information. Local thresholding techniques are used with document images having non-uniform background illumination or complex backgrounds, such as watermarks found in security documents if the global thresholding methods fail to separate the foreground from the background. This is due to the fact that the histogram of such images provides more than two peaks making it difficult for a global thresholding technique to separate the objects from the background, thus; local thresholding methods are the solution.

H. Log Transformations

The log transformation maps a narrow range of low input grey level values into a wider range of output values. The inverse log transformation performs the opposite transformation. Log functions are particularly useful when the input grey level values may have an extremely large range of values. Sometimes the dynamic range of a processed image far exceeds the capability of the display device, in this case only the brightest parts of the images are visible on the display screen. To solve this problem an effective way to compress the dynamic range of pixel values is to use the Log Transformations, which is given by,

$$g(x, y) = c. \text{Log}(1 + r)) \quad \ldots\ldots\ldots\ldots\ldots \quad (3.2)$$

Where c is constant and it is assumed that $r \geq 0$.This transformation maps a narrow range of low-level grey scale intensities into a wider range of output values. Log Transformations is used to expand values of dark pixels and compress values of bright pixels. Inverse log transform function is used to expand the values of high pixels in an image while compressing the darker-level values. Inverse log transform function maps the wide range of high-level grey scale intensities into a narrow range of high level output values.

I. Log Transformations

Previous methods of histogram equalizations and histogram matching are global. So, local enhancement is used. Define square or rectangular neighborhood (mask) and move the center from pixel to pixel. For each neighborhood, calculate histogram of the points n the neighborhood obtains histogram equalization /specification function. Map gray level of pixel centered in neighborhood. It can use new pixel values and previous histogram to calculate next histogram.

TABLE I. COMPARATIVE ANALYSIS OF IMAGE ENHANCEMENT TECHNIQUES

S.N.	TECHNIQUES	ADVANTAGES
1	Histogram equalization	This technique is very simple. Only the global histogram equalization can be done completely automatically.
2	Adaptive Histogram equalization	This method has advantage of being quick making it simple based on transform adaptive histogram. The results of this technique shows outperform from commonly used enhancement technique like histogram equalization.
3	Fuzzy Logic Technique	The fuzzy rule-based approach is a powerful method for formulation of expert system in a comprehensive way. Fuzzy logic represents the good mathematical frame works to deal with uncertainty of information.
4	Nuro Fuzzy System	The neural networks used for identification of noise using the statistical parameters whereas fuzzy logic is used for enhancement purpose. The system behaves like a neural network where learning of parameters occurs and at the time of execution it behaves like a fuzzy.
5	Unsharp Masking	This is the simple technique. In this technique, a fraction of the high-pass filtered image is added to the original one to form the enhanced image. It has two major drawbacks. First it enhances the noise present in the image. Second, it enhances too much the sharp transitions which lead to excessive overshoot on sharp edges.
6	Contrast Stretching	Contrast Stretch is the simplest contrast stretch algorithm that stretches the pixel values of a low-contrast image or high-contrast image by extending the dynamic range acros the whole image spectrum
7	Thresholding transformations	Thresholding transformations are particularly useful for segmentation in which we want to isolate an object of interest from a background.
8	Log Transformation	Log Transformation is Useful for enhancing details in the darker regions of the image at the expense of detail in the brighter regions the higher-level values.
9	Local Enhancement	This technique is very simple to use. In this technique we define a define square or rectangular neighborhood and move the center from pixel to pixel.

III. Conclusion And Future Work

Above table shows those different techniques and their advantages. This paper surveys some of the areas where image enhancement is done. This paper presents the most important techniques for image enhancement in digital image processing. Although this paper did not discuss the computational cost of enhancement techniques it may play a critical role in choosing a technique for real time applications. Despite the effectiveness of each of these algorithms when applied separately, in practice one must devise a combination of such methods to achieve more effective image enhancement.

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Sensor Networks and its Application in Electronic Medicine

Detailed Analysis of its Prospects, Challenges, and Socio-Economic Impact

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***Abstract*— In recent times, there has been a tectonic shift in the manner through which medical services are being rendered and the organization of the practice of Medicine as a whole. This tremendous diversification in the techniques employed for medical service delivery has noticeably been achieved through the integration of Engineering with medical sciences and the efficient latch of Medicine on constant improvements across the field of Computer and Electronic Engineering. Treatment of patients, medical research, education, disease tracking and monitoring of public health have been efficiently optimized through innovations in Engineering. To this effect, medical practices in advanced countries have now transitioned from being largely one-to-one/human-to-human interactivity to a characteristic distributed healthcare delivery system whereby patients can receive both remote health advice as well as remote medical treatments usually through electronic gadgets operating within a standardized Sensor Network (SN) architecture. This paper seeks to explore the concept behind Sensor Networks, the technology framework, its application in the field of Electronic Medicine, prospects, challenges, ethical issues and a thorough analysis of the socio-economic impact of this new application of Electronic and Computer Engineering in Medicine**

Keywords-component; Sensor Networks, E-Health, Medical Electronics, RTOS, Wi-Fi, Bio-sensors, Socio-Economic Impact

I. INTRODUCTION

As with any other initiative, the revolution of medicine through the introduction of electronic healthcare delivery and monitoring has brought about visible economic and social impact which is perceived by citizens of different countries in different lights, mostly based on how well they feel the recent innovations have improved the kind and quality of healthcare services delivered to them. Some countries like the United States of America (USA) have recently invested billions of dollars in electronic healthcare schemes. In 2009, the Obama administration approved a $27 billion stimulus package to accelerate health-care information technology in the United States [1] and countries like the United Kingdom (UK) and Netherlands are known to have been spending an average of about 8.5% of their annual Gross Domestic Product (GDP) on healthcare since 2013.

Although acceptance levels for Electronic Medicine (Information and Communication Technology based healthcare delivery) initiatives are high in many countries, Governments still seek to justify and ascertain that the required capital needed to stabilize this industry in their countries is worth the tax payers' money while also keeping abreast the possible far-reaching impact this industry might hold for the nearest future. This paper takes a holistic look at Sensor Networks (SN), its application to Electronic Medicine and seeks to discuss other important factors associated with this new form of medical service delivery.

In a nutshell, the remaining sections of this paper prove an overview of Sensor Networks followed by highlight of its application to Electronic Medicine and then concludes with a thorough analysis of the challenges, risk, ethical issues, socio-economic impact, prospects and cost-benefit analysis of Electronic Medicine to modern economies, especially the UK.

II. OVERVIEW OF SENSOR NETWORKS

Sensor networks which are either wireless or wired are a network of sensors consisting of spatially distributed autonomous devices (nodes) which use sensors to monitor physical, physiological or environmental conditions [2]. These nodes cooperatively work together to engineer the flow of measured data between themselves and ultimately to a gateway which provides connectivity back to the central processing server and in some cases, other distributed nodes. The nodes in the Sensor Network usually range from a few to several thousands, depending on the scale at which the sensor network is to be implemented and the required performance level. Most times, each node is connected to not just one other sensor, but several more, to form a star, tree, ring or mesh topology where information is propagated through either proper routing or share flooding of data [3][4]. This is made

possible, as each network node has typically several technical components such as controller circuits, transceivers, batteries and electronic circuits for interfacing with the energy source and sensors.

The dynamism of operation of these components most times require the SN Architect to make important trade-offs between characteristics such as battery life, transmission data rates, security, mobility, transmission latency and maximum network range per node. As we know, higher radio data rates in battery powered systems and recurrent radio use lead to the consumption of more power, consequently the depletion of the node's battery life. In the case of Wireless Sensor Networks (WSN) - a subcategory of Sensor Networks, in order to meet the long battery life requirement, many Architects opt for the ZigBee wireless network module for the wireless connectivity of the sensor nodes and inter-node data transfer, as this networking standard offer fairly fast transmission data rate with less power consumption as against standards such as Wi-Fi and Bluetooth, even though these offer faster data transmission rates.

Ultimately, these networked sensors enable dense spatiotemporal sampling of physical, physiological, psychological, cognitive, and behavioural processes in spaces ranging from small personal space to large spaces such as in buildings. Such dense sampling across spaces of different scales has today been adapted and the concept harnessed for sensory information based healthcare applications [5].

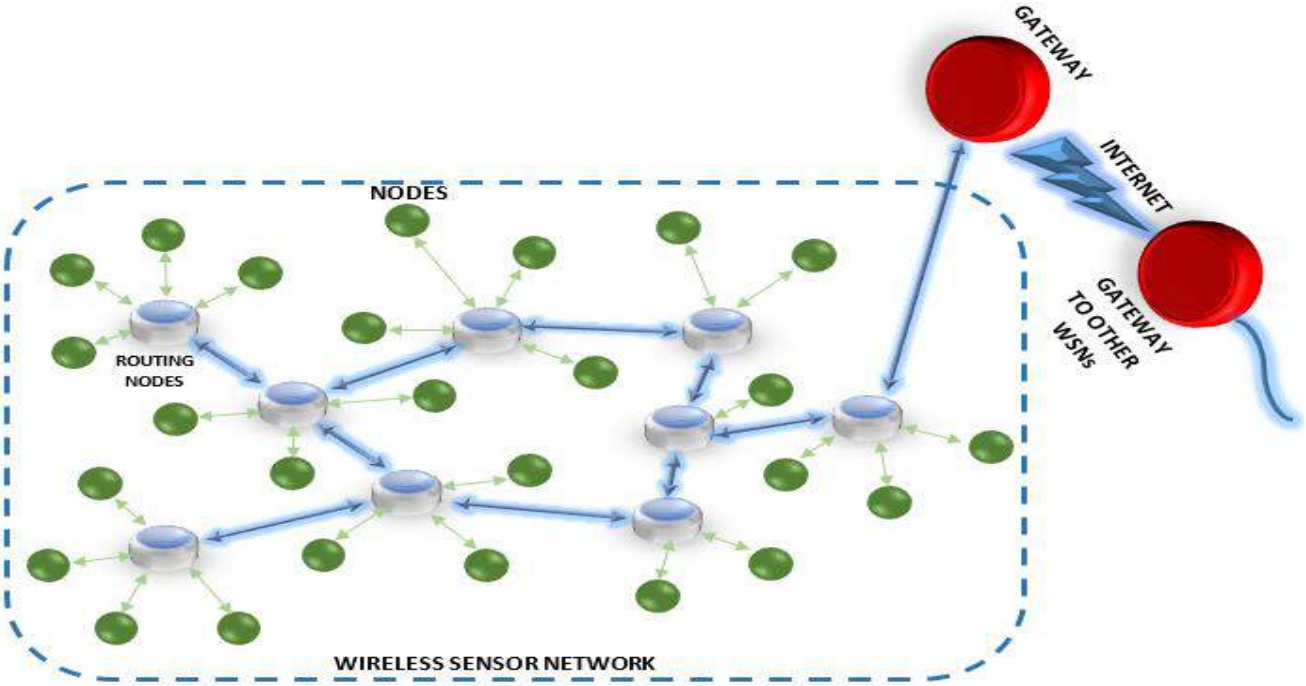

Figure 1. Modelled Sensor Network and Its Distributed Nodes

A. *Nodes, Topology and Architecture*

SN nodes are usually organized in ways which offer the architecture developer a high level of flexibility and allow for its best utilization in the desired task/domain. The sensors in the nodes are usually categorized as either physiological, bio-kinetic or environmental sensors. There are quite a number of SN topologies, however, the three major kinds of topologies include:

- Star Topology
- Cluster Tree Network Topology
- Mesh Network Topology

For the star topology, each node is designed to connect directly to a gateway while in a cluster tree network topology, each node is connected to a node higher in the tree and then finally to the gateway which connects the entire network back to the control centre. The mesh network on the other hand is designed to be more reliable, as its nodes are able to connect to multiple other nodes within the network and also pass data through the most reliable path available. Figure 2 below shows a graphical representation of the 3 major topologies.

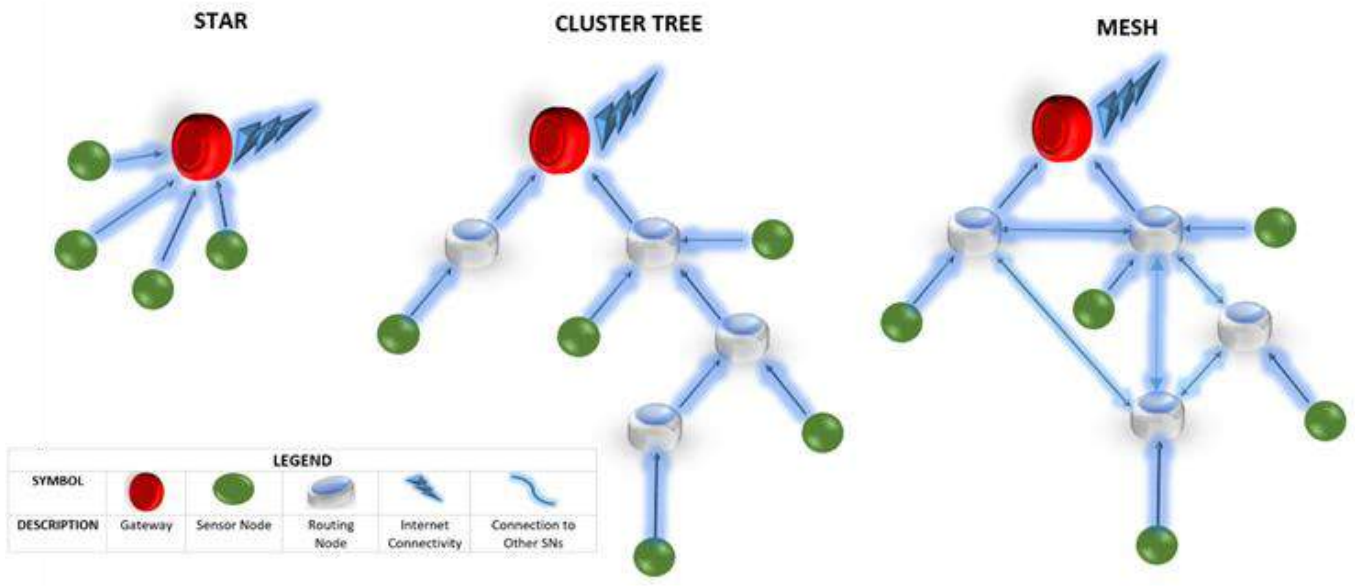

Figure 2. Figure Showing Common Sensor Network Topologies

Figure 3. below shows the diagrammatic representation of the basic components of a sensor node. These nodes usually have microprocessors/microcontrollers which operate on embedded Real Time Operating Systems (RTOS) such as Tiny OS which are responsible for managing the nodes and facilitating communication with other nodes [6].

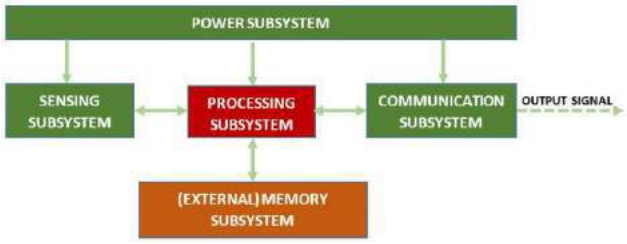

Figure 3. Block Diagram Showing Components of a Typical Sensor Node

B. *Technical Considerations*

In building a sensor network, especially for medical purposes, various technical considerations need to be put in place, these considerations are usually classified into physical, network and continuous monitoring considerations as explained in the sections below. While SN Architect's strife to meet the long-lasting battery life requirement of the Sensor Network nodes, elements such as the size and weight of the batteries also have to be considered. Although with bigger battery packs, extended battery life can be achieved, most times, in order to extend battery life in Sensor Networks, node are usually designed to periodically sleep, wakes up, transmit required data and return back to sleep with minimal power usage. It is important to note that the processors incorporated in Sensor Network nodes are usually able to efficiently inter-switch between sleep and wake modes while still maintaining effective processing speeds.

1) *Physical Consideration*

Considering the fact that Sensor Networks are swarms of multiple interconnected physical devices which are usually attached to carriers (animate or inanimate), some key physical considerations are usually made during the design phase. These considerations include:

- Ergonomics
- Individual needs
- Cultural difference
- Size
- Weight

2) *Continuous Monitoring Consideration*

As we know, activities such as remote health supervision, emergency rescue and chronic disease monitoring all require a high level of reliability and security (data integrity & authenticity) as well as low latency and power consumption. In order to ensure uninterrupted continuous monitoring, factors such as are listed below are usually considered:

- Nodes battery life-time
- Device reliability
- Security of architecture

3) *Network Considerations*

Most Sensor Networks operate via wireless connectivity (Wireless Sensor Networks). In order to ensure optimal performance of the wireless transmission of data and also make sure other physical and continuous monitoring requirements/considerations are not violated, careful considerations in the following areas are made:

- Maximum range per node
- Network protocols used

- Data transmission rates of network protocol used
- Provision against interference

Figure 4 below shows a graphical representation of power consumption in relation to various wireless network standards and their output transmission data rates. It succinctly depicts how much the network considerations affect other continuous monitoring considerations (such as node's battery life) as highlighted above.

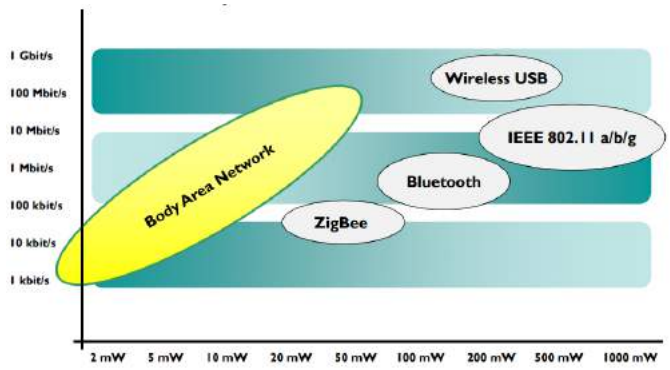

Figure 4. Figure Showing Power Consumption vs Data Rates for Different Wireless Networking Standards [7]

C. *General Application of Sensor Networks*

In recent times, Sensor Networks have found applications in various spheres of life, few of which include:

- Healthcare
- Environmental monitoring
- Asset tracking
- Sophisticated structural monitoring

III. Sensor Networks and Electronic Medicine

Electronic Medicine which is defined by the World Health Organization (WHO) to be the use of Information and Communication Technologies (ICT) for healthcare deliveries such as treating patients, conducting medical research, educating the health workforce, tracking diseases and monitoring public health [8] has become a prevalent method of medical practice in modern countries. It mostly involves the transfer of health resources and administration of healthcare by electronic means.

Considering the fact that SNs are distributed and self-organized network of tiny and extremely constrained nodes with sensing, processing and communication capabilities that interact with each other to carry out specific tasks [9], this model has now found many suiting applications in areas such as consumer/industrial machine monitoring, asset tracking, environmental, process and structural monitoring, electric smart grid supervision and less invasive electronic health monitoring and treatment. The power, range and memory constraint characteristic of the SN nodes poses a major challenge to the industrial and research community, especially regarding efficient deployment.

This notwithstanding, it is interesting to know that today, many healthcare devices and systems are now operated based on the SN model in forms called Biomedical Wireless Sensor Network (BWSN). These are primarily small-size Wireless Enabled Sensor Networks designed for medical applications or healthcare services [10]. BWSNs work by interfacing wireless enabled SN nodes (usually devices with biosensors on them) with patients in order to measure, monitor and transmit real-time health condition through the gateway to central data processing points which could help trigger healthcare attention from an actual medical professional or through other automated processes.

A. *A Critical Part of Wireless Sensor Networks (Sensors)*

The nodes of SNs usually consists of one form of sensor or the other which aids in data acquisition. In Electronic Medicine, these sensors are called bio-sensors. Bio-sensors are simply sensors with the ability to detect biological molecules and communicate its gleaned information through a variety of output signals. As such, devices like this have been employed for the in-vitro diagnosis of a number of diseases and conditions. The blood sugar test devices and pregnancy test strips are evident examples. The model behind implantable biosensors is made up of:

- The Bio-recognition layer (bioreceptors and transducers)
- Transceivers
- BAN gateway/Processor
- Monitoring server/ Communicators

The biorecognition layer usually have in place a suitable enzyme or biological molecule with affinity for the target molecule, which when binding occurs in turn creates an effect for detection by the transducer. These transducers are usually able to convert biological changes to electrically interpretable forms. Transducers come in various forms based on the transduction principle being applied. The most common method is the electrochemical sensors, which apply electrochemical principles and involves techniques such as amperometry, conductimetry, potentiometry, impedance, and electro chemiluminescence, a current strategy being used in the biosensor field.

The transceivers which are usually paired with the biosensors help to receive, amplify and transmit the signals using low-consumption network to the processor. The processor in turn processes data collected into a readable form, saves it on the monitoring server (if available) and sends it to the display monitors/communicators (if also available).

The ability of biosensors to bind to in-vivo molecules (bio-receptors) is known to be an harness-able tool in drug discovery and pharmacokinetics. This tool pledges to advance on the methods by which drug-binding modes are demonstrated, hence facilitating superior predicting potential modifications and improvements on lead compounds.

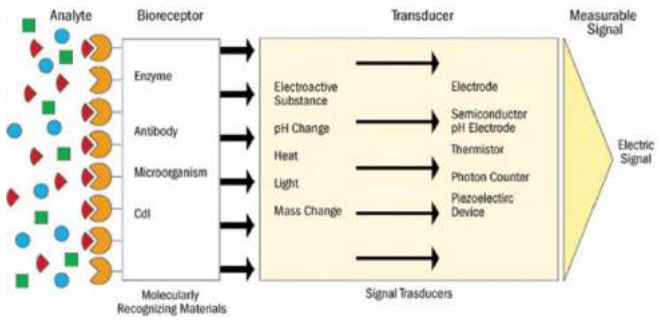

Figure 5. Figure Showing Granular Biosensor Activity [11]

B. *Application of Sensor Networks in Electronic Medicine*

Biomedical Wireless Enabled Sensor Networks have been tipped to possess tremendous potential in improving the quality of healthcare delivery in areas of patient monitoring and emergency response. The availability of these SN model has fostered the development of new applications and services primed towards improving the quality and spontaneity of medical care administered to patients, providing even better, seamless and faster services. In summary, the major applications of SN in electronic health/medicine are highlighted in the subsections below.

1) *Real-Time Continuous Patient Monitoring*

Patients with critical health conditions often need lots of monitoring, primarily monitoring of vital signs (heart rate, blood glucose level, temperature etc.). Ordinarily, this will result in the attachment of multiple monitoring devices to the patient's body which is mostly wired [12]. For this application, BWSN-based Electronic Medicine devices are built to help monitor (multiple) patient's vital signs without having to jumble them up with loads of wires. BWSN-based devices in this area basically serve as replacements for wired medical monitoring devices.

2) *Home Monitoring For Chronic Diseases and Elderly Patients*

In many countries today, many aged and elderly people are not chronically ill, but however, require healthcare in one way or the other. Rather than filling up hospital beds with non-critically ill people who need less help, BWSN-based medical devices have been created which can help with the routine collection of patient's health status data to help track condition and also allow for the possibility of carrying out long-term trend analysis of patient's health conditions. A typical example of this is the SENSIMED-Triggerfish BWSN-based device which provides an automated recording of continuous ocular dimensional changes over 24 hours. It uses a soft disposable silicon contact lens which has an embedded microsensor in it used to capture spontaneous circumferential changes at the corneoscleral area (around the eyes). An adhesive antenna which is placed around the eye receives wirelessly the information from the contact lens and transmits it to a recorder and other ad-hoc devices for further processing [13].

3) *Collecting of Long-Term Database of Clinical Data*

Since Sensor Network-Based devices communicate most times with a central processing server used for data processing, storage and recommendation generation, meaningful data related to a patient's health can be seamlessly accumulated over time, and correlation can be made between the patient's data to other patients within the same class (e.g. age range, economic status, race etc.). In essence, longitudinal studies across populations can be carried.

4) *Assistance With Motor and Sensory Decline*

New Sensor Network-based devices such as the smart spoon in [14] and the soft robotic gloves designed by Wyss Institute for Biologically Inspired Engineering and the Harvard School of Engineering now exist. For example, the soft robotic gloves help people suffering from loss of hand motor control to regain some of their independence by making use of information about the patient's physiological and physical state (gleaned through streams of attached sensors) to provide adaptive medical assistance to the patient [15]. Increasingly, typical assistive devices such as walkers, wheel chairs, and crutches are now built to fuse in sensors and other artificially intelligent components which can use information from built-in and external sensors to provide the users with continual personalized feedback and guidance towards the correct usage of the devices [16].

C. *Biomedical Wireless-Enabled Sensor Network (BWSN) Peculiarity*

It is important to note that the Sensor Networks have been adapted in electronics medicine, primarily making use of sensors around the body operating within a Body Area Networks (BAN). This BAN is interfaced with a mobile phone/technology which serves as the immediate personal server for data processing as well as a gateway for the BAN sensors to other BANs and the central computing server which processes, interprets the data received, and forwards the extracted information to the medical service provider for appropriate medical actions. At times, E-Health devices working within the BAN are able to receive feedback information remotely and also take some required first aid action in the case of critical health conditions. Figure 5 below shows a typical BWSN architecture designed to work outwards from within a BAN while Figure 6 shows the implementation of the three major Sensor Network topologies on a human body.

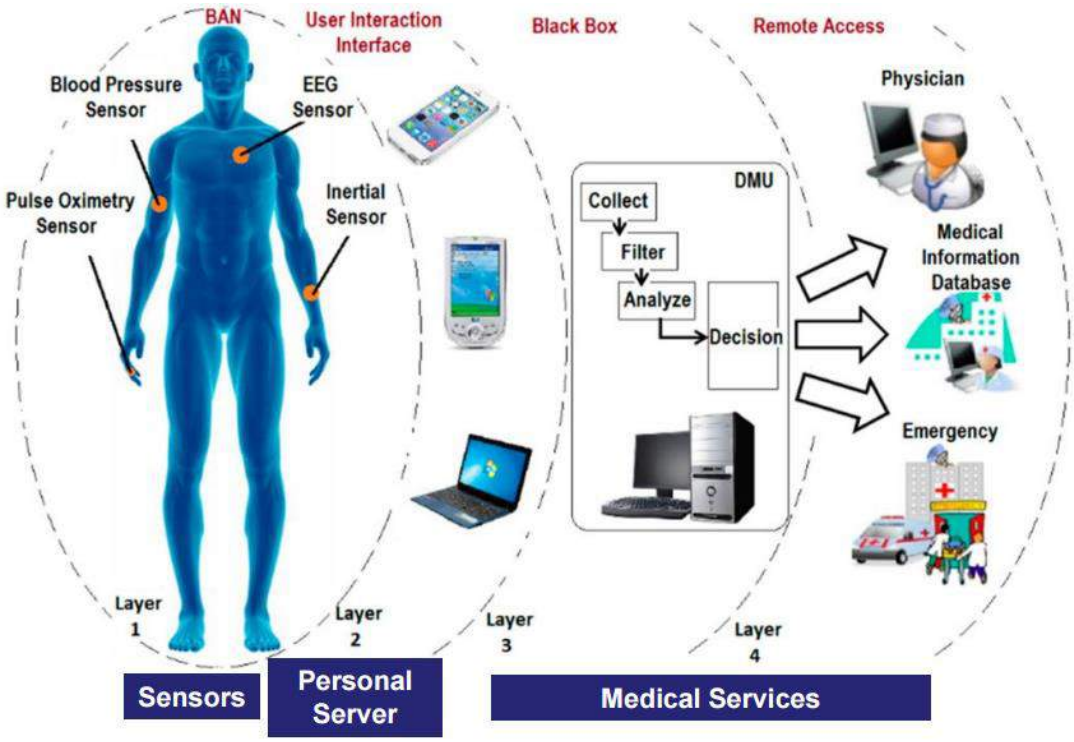

Figure 6. A Typical BWSN Architecture Designed to Work Outwards from Within A BAN [7]

Table 1 below shows in a tabular form the main differences between a regular Wireless Sensor Network implemented for an outdoor or industrial application against an adapted version (BWSN) which is usually implemented for medical purposes.

TABLE I. TABLE JUXTAPOSING BWSN ARCHITECTURE SPECIFIC REQUIREMENTS AGAINST NORMAL SENSOR NETWORK'S

S/N	*Sensor Network*	*Biomedical Wireless Enabled Sensor Network*
1	Mostly covers the environment	Covers the human body
2	Large number of nodes	Fewer sensor nodes
3	Multiple dedicated sensors	Single multitasking processor
4	Low accuracy	Robust and accurate
5	Medium security needed	High level of security needed (patient's data involved)
6	Data loss, less of an issue	Sensitive to data loss (every data is critical)

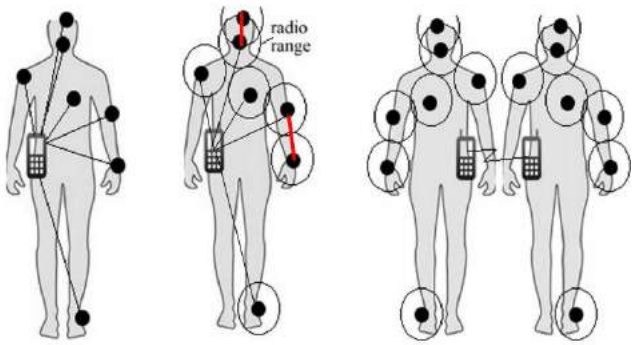

Figure 7. Figure Showing Different Sensor Network Topologies on a Human Body [7]

D. *Case Study (Google Smart Contact Lens)*

Google's smart contact lens monitors and tracks user's glucose level and send the gleaned information to a mini server (e.g. a mobile phone) device wirelessly for processing and feedback, making the task of monitoring sugar levels far easier. This Biomedical Wireless Enabled Sensor Network-Based Medical Electronic device is believed to be a seeding element for many more such similar BWSN devices that will spring up in the coming years.

Figure 7 below shows components which make up the smart contact lens.

Figure 8. Figure Showing Google's Recently Launched Smart Contact Lens [17]

E. Drivers of Sensor Network Application in Healthcare, Challenges and Ethical Issues

Factors such as aging population, chronic diseases with the need for early diagnosis and prompt medical actions remain the key drivers of the tremendous level of growth the Electronic Medicine industry has witnessed in recent years. However, challenges still exist in areas such as data heterogeneity and energy limitations in implantable nodes which most times result in the need for frequent replacements. The importance of the kind of data BWSNs carry dictates the need for a high level of Quality of Service (QoS) in order to maintain patient's data privacy. However, considering the fact that internetworked devices can easily be hacked, this level of data integrity and authentication cannot be guaranteed. In a nutshell, the main ethical issues resulting from the use of Sensor Networks in Medical Service delivery include:

- Patient-to-Doctor Gap
- Data Privacy Issue
- Hacking and Manipulation

Patients now increasingly rely on the recommendations of this devices on many occasions as against thorough consultation with the doctor. Data stored and transmitted by the SN nodes are expected to remain private, however, there is no guarantee that these transferred data have/will not be breached. Sensor Networks-Based devices can be and manipulated to provide wrong recommendations to patients [18]. For cases like this, it remains an ethical issue as to who it is to blame for resulting mishaps.

Despite the recent advances observed with BWSNs, notable risks still remain which cannot be overlooked and for which precautionary measures must be taken by system architecture designers as stated by European group on Ethics in Science and New Technologies. A few of these risk areas include.

- Incompatibility and adverse tissue reaction
- Migration of implanted device
- Electromagnetic interference
- Failure of the system and need for replacement surgery

In dealing with the current risk, advancement in research for more miniaturized devices which still need to be powered has prompted the research and development of alternative power sources, as power supplies such as batteries are difficult to miniaturize and need a design that factors in easy replacement or recharging. Hence BWSN devices are being re-evaluated to factor in proposed self-powering mechanisms based on chemical-to-electrochemical energy transformations in biofuel cell (BFC) elements [19]. Self-powered bio-sensing have three proposed classes based on the basis of biocatalyst such as microbial fuel cells, enzymatic BFCs and mitochondrial BFCs. Successful development of such BFCs would greatly reduce risks associated with implantable devices such as implant failure, replacement due to dead power supply, electric hazards and the need for an external power source.

Proposed self-powered biosensors will be able to produce sufficient energy for signaling and need no external source nor metal catalyst. Other biological molecules could be used to control them as modulators, which will either inhibit or activate the catalyst

IV. Prospects And Socio-Economic Impact Of The Application Of Sensor Networks To Medicine

Currently, about 8% of the United Kingdom's (UK) Gross Domestic Product (GDP) is spent on healthcare, sharing over £120 billion in the 2016/2017 annual budget [20]. Although we know that no healthcare system anywhere in the world has really achieved levels of spending sufficient enough to meet all its citizen's healthcare needs [21], research has shown that with the huge chunk of the healthcare budget spent on medical research all across the country, the area of Electronic medicine will only continue to grow as an increasing number of citizens now opt for ICT based medical services on a daily basis. Figures 8 and 9 below give more insight into the recent large-scale financial investment made by different countries on healthcare.

The negative effect of the ever-present scarcity of resources (limited time of surgeons, bed spaces, specialized equipment) has in recent times been cushioned by the effectiveness of electronic medicine which has been made possible via the implementation of sensor network based models of healthcare delivery for adequate patient monitoring, education, record keeping and at times first aid administration in emergency cases. Cost-effectiveness analysis has shown improvement in the number of life years saved since the recent massive introduction of e-health devices/medical electronics into the UK medical industry and other countries such as the Netherlands and USA [20].

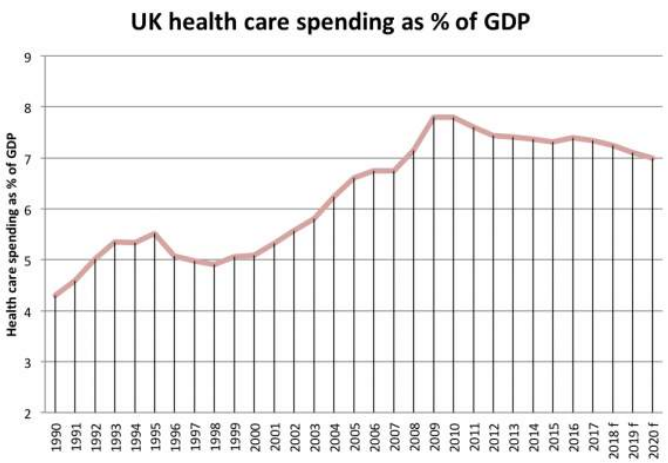

Figure 9. UK Healthcare Spending as a Percentage of GDP (1990 to 2020) [22]

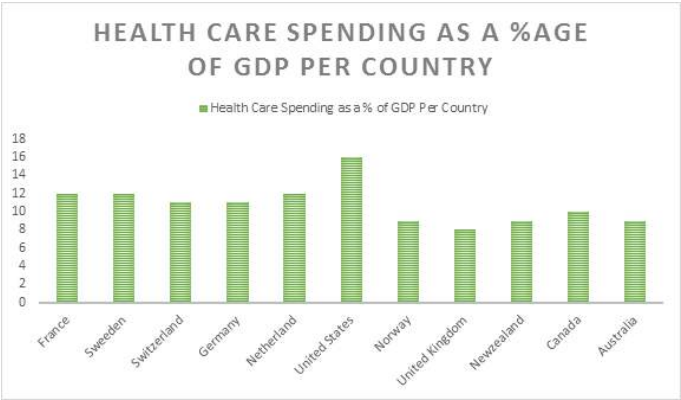

Figure 10. Chart Showing HealthCare Spending as a Percentage of GDP for Different Countries in 2013 [23]

V. Conclusion

It is indeed a fact now that spatiotemporal sampling of physical, physiological, psychological, cognitive, and behavioural processes through the use of networked sensors have now been reengineered and made applicable to the field of Medicine. They have also gained firmness and are increasingly becoming standard options for handling some healthcare procedures. Although both technical and ethical challenges still exist in the efficient and effective deployment of networked sensor nodes for medical activities, it certainly has proven to provide positive cost effectiveness.

Over the years, European, Asian and the American countries have consistently invested billions into their healthcare sectors, much of which has ended up funding researches towards the improvement and standardization of various Sensor Network Based medical models. Indeed, the application of Sensor Networks in Electronic Medicine is now well grounded and is definitely here to stay.

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